

The Thistles of Canada



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The Thistles of Canada

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INTRODUCTION

The tribe Cardueae of the large family Compositae contains nine genera found in Canada, either as native or as introduced plants.

The largest native genus is *Cirsium*, the true thistles. For many years, problems have existed regarding the correct names, relationships, and distribution of our native species of *Cirsium*, and we have carried out special studies on these species. These previously published investigations are summarized here.

The correct identification and knowledge of the distribution and biology of naturalized species is also of interest and importance. A number of these adventive species of the Cardueae are serious weeds in agricultural areas of North America.

In this publication, various facets of information are brought together: description, native and Canadian distribution, economic uses, cytological data, and comments on the evolution of the genera. Keys and illustrations facilitate identification of the plants. Dubious reports of the occurrence of certain species in Canada have been investigated by a search for supporting herbarium specimens in the institution where the collections of the author of the report are preserved. Some reports are known to be based on incorrect identification of plants; others, lacking specimen support, are considered to be probable errors. Distribution maps are included for native species only.

It is intended that this publication will be useful to the public with botanical interests and also to the professional botanist, for whose benefit the more technical details are included.

BOTANICAL TERMS

Some of the specialized terms used to describe the plants of this group are explained in the following paragraphs. Other terms of more common usage will doubtless be known to botanically interested persons. As a further aid there is appended a glossary of commonly used terms, emphasizing the meaning as applied to these plants.

In plants of this tribe, the flowers (florets) are small and are borne in a capitate cluster (head, capitulum). The head is enveloped by several circles of reduced, modified leaves (phyllaries, involucre bracts). The structure of the globular flower cluster of the genus *Echinops* differs from that of the other genera in that each floret is surrounded by an involucre and many involucre are assembled in a globular cluster. Each floret of *Echinops*, with its involucre, is thus comparable with an entire head in the other genera.

The gamopetalous corolla of the floret consists of a narrow basal portion (tube), followed by the broader limb made up of the throat (undivided portion) and the separate lobes. The lengths of these parts of the corolla are sometimes of significance in separating species. Usually all the florets of a head are

similar in size and function, but in some species of *Centaurea*, the peripheral florets are much larger than the inner florets. The larger, ray-like florets are sterile, lacking functional sexual parts, whereas the central florets are fertile, with normal male and female parts. The ovary of all Cardueae species develops into a single seed (achene).

At the summit of the achene there is usually a pappus — a circle of structures the character of which varies in different genera from soft or harsh hairs to bristles or scales. Often the pappus consists of many fine, soft filaments, which may be branched and feather-like (in *Cirsium*) or unbranched (in *Carduus*). A pappus is sometimes lacking.

The fleshy expanded terminal portion of the floral stem, which bears the florets, is called the receptacle. The receptacle may be flat or curved; it may bear hairs, scales, or other structures among the florets, or may lack such structures (receptacle naked).

The achene that develops from each floret is attached to the receptacle by a short stalk, which may enter the achene at its base (attachment basal) or on the side near the base (attachment lateral). Some intermediate conditions also occur. The matter of the point of attachment has been used to separate several species-groups of *Centaurea* into segregate genera.

SYNONYMY

It is often found that several names have been applied by different botanists to the same species of plant, and it remains for a later author to determine which of the names is botanically correct. According to the rules of nomenclature, the earliest validly published name must be used, and other names which the botanist believes refer to the same species are placed in synonymy. For many of the species treated here, many specific epithets that probably refer to the same species are found in the literature. Except in *Cirsium* we have generally not attempted to list all synonyms but only those sometimes encountered in the more commonly used literature. Reference is often made to monographs or comprehensive floras in which a more complete synonymy is given.

HERBARIUM SYMBOLS

The collections in the herbarium of the Canada Department of Agriculture, Ottawa, have been the primary source of study material, but specimens preserved in other Canadian and some United States herbaria have been examined, particularly to determine the distribution of species. The location of some specimens is indicated in the text by the customary symbols: DAO — Canada Department of Agriculture, Ottawa, Ontario; CAN — National Herbarium of Canada, Ottawa, Ontario; V — British Columbia Provincial Museum, Victoria, B.C.; QK — Queen's University, Kingston, Ontario; QFA — Laval University, Quebec.

Tribe Cardueae Cassini, J. Phys. Chim. Hist. Nat. Arts 88:155. 1819. "Carduineae"

RECENT LITERATURE

- O.T. Solbrig. The Tribes of Compositae in the southeastern United States. J. Arnold Arb. 44:436-461. 1963.
- G. Wagenitz. Campanulales, in Engler's Syllabus der Pflanzenfamilien. II, 494. Berlin. 1964.

Plants herbaceous. Leaves alternate, entire to deeply pinnatifid and usually spiny-margined; leaf bases sometimes decurrent and forming spiny wings along the stem. Heads usually homogamous, of tubular flowers but sometimes heterogamous, with larger sterile, marginal flowers; tubular flowers usually perfect, rarely dioecious. Involucre of several rows of phyllaries; phyllaries usually spiny-tipped, glandular or eglandular. Anthers united laterally and with elongate, sterile apical appendages and usually also basal appendages. Stigmatic branches short, with a thickened pubescent ring below the union of the branches. Pappus bristly or plumose, rarely paleaceous or lacking. Achenes narrow, the attachment scar on the base of the achene or on the side of the achene near the base. Receptacle dry, firm or fleshy, bearing hairs, bristles, or chaff, or naked.

The tribe consists of about 50 genera, mostly of the northern hemisphere and mainly Eurasian in origin. Most of the genera are centered in the Mediterranean region and Asia Minor. In Canada, the genera *Cirsium* and *Saussurea* are indigenous; species of *Arctium*, *Carduus*, *Centaurea*, *Cnicus*, *Echinops*, *Onopordum*, and *Silybum* are naturalized introductions.

KEY TO THE GENERA

- A Involucre containing a single flower: each flower surrounded by several rows of phyllaries and many involucre aggregates into a compact globular cluster *Echinops*
- A Involucre containing many flowers: each flower not enclosed by scales or bracts.
 - B Achenes with basal attachment (point of attachment of achene to receptacle at base of the achene).
 - C Receptacle of head flat and bearing bristles (rarely glabrous in *Saussurea*).
 - D Staminal filaments free.
 - E Tips of outer involucre phyllaries hooked (recurved spine). . . *Arctium*
 - E Tips of outer involucre phyllaries straight, often spiny but the spines straight, not recurved.

- F Leaves spiny-margined.
 - G Pappus setae plumose. *Cirsium*
 - G Pappus setae simple, not plumose. *Carduus*
- F Leaves not spiny-margined. *Saussurea*
- D Staminal filaments united. *Silybum*
- C Receptacle of head without bristles but with chaff-like partitions enclosing the achenes. *Onopordum*
- B Achenes with lateral attachment (point of attachment on side of the achene) — (oblique-basal in *Centaurea repens*).
 - H Pappus of achenes consisting of short scales or bristles, or pappus lacking. *Centaurea*
 - H Achenes crowned with a ring of 10 short horny teeth and, within this, a ring of 10 long and 10 short rigid bristles. *Cnicus*

The following simplified key to the genera may be easier to use with some specimens.

- A Leaves not spiny-margined.
 - B Tips of phyllary spines recurved, forming a hook. *Arctium*
 - B Phyllaries spiny or not, but not hooked.
 - C Achenes attached by the base to the receptacle. *Saussurea*
 - C Achenes attached laterally (on side, near base). *Centaurea*
- A Leaves spiny-margined.
 - D Flower heads perfectly spherical and without an involucre at the base of the head. *Echinops*
 - D Flower heads not spherical and always with an involucre enclosing the florets.
 - E Pappus of achenes consisting of a ring of 10 short horny teeth and, within this, 10 long and 10 short rigid bristles. *Cnicus*
 - E Pappus otherwise.
 - F Pappus plumose. *Cirsium*

F Pappus not plumose.

G Staminal filaments united laterally; achenes large (6-7 mm);
leaves green and conspicuously mottled *Silybum*

G Staminal filaments not united; achenes smaller (to 5 mm); leaves
green or gray but not mottled.

H Achenes enclosed in honeycomb-like cells of the naked,
fleshy receptacle *Onopordum*

H Achenes not enclosed in cells; receptacle densely bristly. . *Carduus*

ECHINOPS Globe thistle; échinope

Echinops L., Sp. Pl. 814. 1753.

Perennial herbs, 2 m high. Stems erect, spiny. Leaves alternate, elliptic in outline, pinnatifid or dentate, the segments spine-tipped. Flower heads large, spherical, composed of many one-flowered involucre. Involucre consisting of several series of unequal, spinescent, chaff-like bracts that in some species are united into a tube, but in other species are free; corollas white or light blue, consisting of a very narrow tube and a much broader 5-lobed limb. Pappus of numerous short, chaffy bristles, either separate or fused into a membrane.

This genus of probably 120 species (Bobrov 1962) extends across Europe, North Africa, and temperate and subtropical Asia to Japan. Two species are found naturalized in Canada.

Uses: Several species are garden ornamentals. Some species are used in veterinary medicine in North Africa (Hegi 1929); some contain echinopsin, a poison similar to strychnine.

KEY TO THE SPECIES

The two species found in Canada as garden escapes are similar in general appearance. Both species lack a phyllary tube (Hayek 1931), the involucre phyllaries being not laterally fused.

Glandular hairs present on stems and upper surface of leaves; backs of involucre bracts puberulent.....1. *E. sphaerocephalus*

Glandular hairs absent from stems and upper surface of leaves; backs of involucre bracts glabrous.....2. *E. exaltatus*

1. *E. sphaerocephalus* L., Sp. Pl. 814. 1753.

Echinops maximus Sievers ex Pall., Neue Nord. Beitr. III, 323. 1796.

Echinops cirsiiifolius C. Koch, Linnaea 24:379. 1851.

Common names. Globe thistle; chardon boulette

Herb, to 20 dm high. Stem branched above, woody, ribbed, white woolly, some hairs glandular-tipped. Leaves elliptic to narrowly obovate, subentire to deeply pinnatifid, sessile or clasping the stem; upper surface green, villous, with many glandular hairs, lower surface densely woolly, marginal spines 2-4 mm long. Heads of light blue flowers, globular, 4-5.5 cm in diam. Involucre consisting of about 16 bracts, 12-17 mm long, in four incomplete overlapping series of five members, progressively longer toward the interior but the innermost series about as long as that immediately external, bracts spatulate,



Echinops sphaerocephalus. *a*, habit, $\times \frac{1}{2}$; *b*, achene with pappus, $\times 2$; *c*, seedling rosette, $\times \frac{1}{3}$; *d*, inflorescence, $\times 2$.

obovate to ovate-lanceolate, margin of upper half irregularly dentate or lacinate, tips spiny, abaxial surface glandular; involucre surrounded by numerous flat, paleaceous setae approximately 1 mm long. Corollas 12-14 mm long; tube 5.5 mm, about one-third the width of the limb, lobes 7 mm long, narrow. Stigma bifid, 2-2.5 mm; anthers 5-6 mm long, dark-colored, filaments stout and glabrous. Pollen $55-60 \times 85-90 \mu\text{m}$. Achenes approximately 10 mm long, 2 mm wide, covered with dense, appressed tawny hairs; pappus about 1 mm, consisting of stiff cilia fused at the base, free at the upper margin.

Chromosome number. $n = 15$ (Moore and Frankton 1962a). $n = 16$ (Poddubnaja 1927; Poddubnaja-Arnoldi 1931).

Native distribution. Southern and central continental Europe, Caucasus, Siberia.

Canadian distribution. This species has been collected in southwestern Quebec, southern Ontario, southeastern Manitoba, and British Columbia.

Reports of the occurrence of this species in New Brunswick and Saskatchewan are believed to be based on misidentifications. Weatherby and Adams (1945) listed it from New Brunswick, but no supporting specimen could be found at the Gray Herbarium by Dr. B. Boivin. He believes that a misidentified specimen has been subsequently revised. It was listed from Regina and Saskatoon, Sask., by Fraser and Russell (1944) and by Breitung (1957). The Regina plant is known to be a misidentification and the probable basis of the report from Saskatoon is a cultivated plant, not a naturalized one.

This species is a garden escape and is found in waste grounds and roadsides. Our earliest collection was made in 1923 at Hurdman's Bridge (Ottawa), Ont. The only extensive occurrence known at present is at Goderich, Ont., where globe thistle occurs in abundance with *Onopordum acanthium*. A survey made in 1948-49 indicated that *Echinops sphaerocephalus* was 10 times as abundant as *O. acanthium* in this area but the latter appeared to be the more aggressive. The time of introduction is not known.

2. *E. exaltatus* Schrad., Hort. Goett. 15. 1809.

Echinops commutatus Juretzka, Verh. Zool.-Bot. Ges. Wien 8:17. 1858.

Echinops strictus Fisch. ex Sims, Bot. Mag. Tab. 2457. 1824.

Herb, to 15 dm high, stem branched. Leaves elliptic-obovate in outline, basal leaves to 25×75 cm, pinnatifid, sometimes segmented almost to the midrib; glabrous and eglandular above, gray and tomentose below; the margin bearing fine 2-3 mm spines. Flowers light blue, in globular inflorescences 4 cm in diam, borne singly at the apex of the branches. Involucres consisting of about 15 bracts, 8-21 mm long, in four series, opposite, progressively longer toward the interior, except the innermost which are shorter by about half than those immediately external; bracts obovate to

elliptic, margin of the upper half usually irregularly dentate or laciniate, the tips long and slender, spreading-reflexed; involucre surrounded by numerous paleaceous, flat, linear setae. Corollas 8-15 mm; tube 2-6 mm, slender, limb much broader than the tube, lobes 5-6 mm. Stamen filaments glabrous and separate; anthers 5-6 mm long, tips acute, body dark, style and stigma 6-7 mm long, stigma 2 mm, bifid. Pollen $60 \times 80 \mu\text{m}$. Achenes about 8 mm long, covered with dense appressed, tawny hairs; pappus about 1 mm, a 5-sided membrane of fused cilia free only at the upper edge.

Chromosome number. $2n = 30$ (Moore and Frankton 1962a).

Native distribution. Southern and central Europe.

Canadian distribution. Collections have been made in southern Quebec, southern Ontario, and southern British Columbia. The species is not a serious weed.

ARCTIUM Burdock; bardane

***Arctium* L., Sp. Pl. 816. 1753.**

Coarse, tall, biennial, nonspinous herbs. Stems stout, usually reddish, with many branches. Leaves alternate, large (basal leaves to approximately 6×5 dm), roundish to ovate or cordate, long-petiolate; green, glabrate above, floccose-tomentose below. Heads numerous, borne in an inflorescence which, in different species, is either racemose or corymbose, or a combination of these forms. Involucre globose; phyllaries numerous, coriaceous, the bases appressed, tips spreading; outer phyllaries lanceolate, attenuate to a stiff hooked tip, inner phyllaries either straight or hooked at the tip. Heads many-flowered, all florets similar, tubular, perfect; corollas purplish, rarely whitish; pappus consisting of several rows of scabrid, separate, and deciduous bristles. Receptacle flat and solid, bearing many bristles. Achenes oblong, flattened, the surface cork-like in texture, rugulose, and longitudinally wrinkled, usually gray or brown and with irregular, darker mottling.

These plants, native to Eurasia, have been variously classified in four to eight species. Opinions of botanists regarding classification differ widely and some taxa are recognized by some authors as species, by others as subspecies or varieties. The most recent monograph (Arènes 1950) recognizes four species with numerous infraspecific taxa. Our treatment does not wholly follow that of Arènes.

Uses. Burdocks, probably mainly the species *A. lappa* and *A. minor*, were used in the Old World from early times as remedies for a wide variety of complaints. Roots of the first year's growth were generally used. Root extract has been used as a laxative, diuretic, sudorific, blood purifier, and hair restorer. The extract was used also in the treatment of mange, falling hair, and skin itch in animals. Root extract has been used as a constituent of "wood tea" and as an emergency coffee substitute (Hegi 1929; Youngken 1948).

In North America, the leaves and roots have been used as food. Rousseau and Raymond (1945) reported that young leaves and dried roots were eaten by the Indians until fairly recently. Yanovsky (1936) also recorded that *A. lappa* was eaten as greens and that the roots were cooked for soup and dried and stored for winter food.

The common burdocks (*A. lappa* and *A. minus*) reached North America with the early English and French colonists. Burdocks are mentioned in some early writings, but we cannot always be certain which of the species is meant.

Josselyn (1672), an English gentleman who visited New England in 1638 and 1663 and spent several years in the colonies, noted in his book published in 1672 that "the lesser Clot-Bur" (p. 44) and "the great Clot-Bur" (p. 86) were present. Apparently he believed the "lesser Clot-Bur" to be native in North America for he included it in a list "of such plants as are common with us in England." The "great Clot-Bur" he recognized to be an introduction and placed it among "such plants as have sprung up since the English planted and kept cattle in New England." It seems probable that Josselyn's "clot-bur"

refers to *Arctium* although this common name is used today for both *Arctium* and *Xanthium* (Fernald 1950). The qualifications “lesser” and “great” suggest that *A. minus* and *A. lappa* are meant, because these species are now known as the “small” and the “great” burdock. Perhaps the more common occurrence of the “lesser Clot-Bur” led Josselyn to believe that it was native to New England. This species (*A. minus*) is today the more common of the two.

A recent translation of the diary of Kalm, a Swedish traveler, states that in July 1749, *Arctium lappa* was growing around a French fort on Lake Champlain (in present New York State) and that the Indians peeled and ate the young shoots (Kalm 1966, I, 387).

KEY TO THE SPECIES

- A Corolla glandular (glandular hairs on exterior of limb) 1. *A. tomentosum*
- A Corolla eglandular
 - B Heads 2-2.5 cm in overall diam (width of involucre to tips of phyllaries), rather conoidal in form when fresh (base broader than top); phyllaries generally ascending; inner phyllaries shorter than the corollas so that the flowers are clearly visible; achenes 4-5.5 mm long 2. *A. minus*
 - B Heads 3 cm or more in overall diam, almost spheroidal in form when fresh; phyllaries generally spreading laterally; inner phyllaries as long as or longer than the corollas so that the flowers are scarcely visible; achenes 6 mm or more in length.
 - C Heads 3-4.5 cm in diam; inflorescence typically corymbose; achenes 6-7 mm 3. *A. lappa*
 - C Heads 3-4 cm in diam; inflorescence racemose, somewhat corymbose-racemose; achenes 6-8 mm 4. *A. nemorosum*

1. *A. tomentosum* Miller, Gard. Dict., 8th ed. Sp. No. 3. 1768.

No common synonyms; for synonymy, see Arènes 1950, pp. 113-114.

Common name. Woolly burdock; bardane tomenteuse

Herb, to 15 dm high; inflorescence regularly corymbiform. Overall width of heads 2-2.7 cm; involucre cup-shaped and appearing open at the top so that the florets do not appear to be enclosed by the appressed phyllaries; the outermost phyllaries mostly reflexed or spreading, 1-1.5 mm wide at the base, green or purplish pigmented and usually densely arachnoid; inner hooked phyllaries ascending, the innermost phyllaries broader, apex obtuse and usually purple-tipped, the tip straight or only slightly curved and as long as or longer than the florets. Corollas deep purple, 12-14 mm long; tube 6-7 mm long, abruptly dilated into the limb, lobes 2.5-3.5 mm. Anthers 5.5-6.0 mm, with acuminate apex. Pollen diam 45-50 μ m. Achenes 5-6.5 mm long, 2-2.5 mm broad.

Chromosome number. $2n = 36$ (Poddubnaja-Arnoldi 1931; Tarnavaschi in Tischler 1950; Mulligan 1961).

Native distribution. Europe and Asia — the limit of the native range runs through southern Sweden and Norway, western France, thence southeastward through Greece to Turkey and thence eastward across Asia to the region of Lake Baikal, thence westward to southern Finland and Sweden.

Canadian distribution. This species is not common, although it has been collected in Newfoundland, Nova Scotia, New Brunswick, Ontario, Manitoba, Saskatchewan, and Alberta. Our collections date from the early 1930's. Collections have been made on roadsides, margins of cultivated fields, waste ground, and river banks. Involucres are glabrate in the form *calva* Fisch.

2. *A. minus* (Hill) Bernh., Syst. Verz. Pfl. 134. 1800.

Lappa minor Hill, Veg. Syst. IV, 28. 1762.

Lappa glabra Lam., Fl. Fr. II, 37. 1778.

The plants treated here would be classed by Arènes (1950) as *A. minus* ssp. *eu-minus*. Complete synonymy is listed on pp. 83-84 of Arènes' monograph.

Common names. Common burdock; cibourroche, chou bourache, bourrier

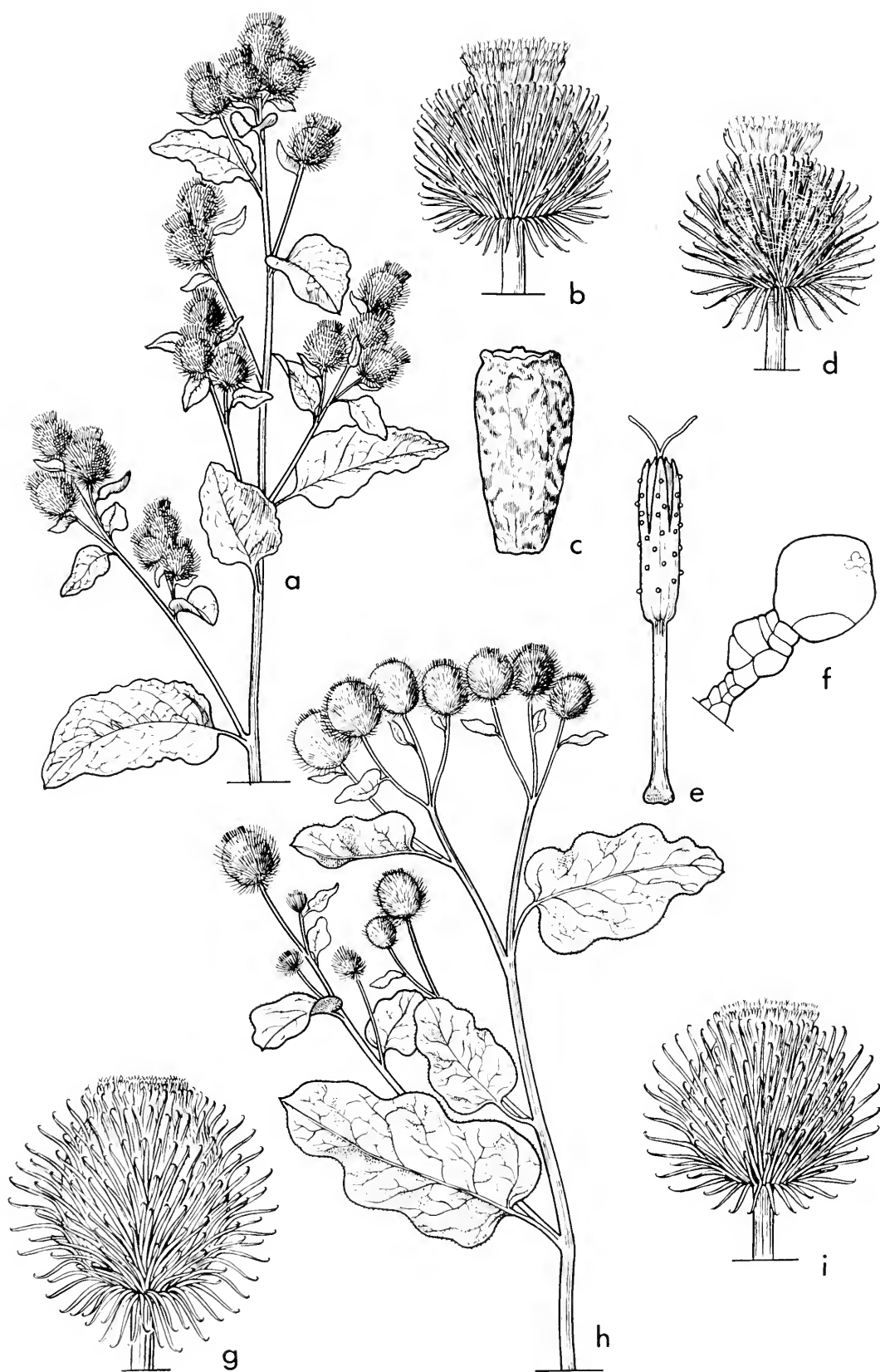
Herb, to 15 dm high. Stem much branched. Basal leaves to 50×35 cm. Inflorescence mainly racemose, sometimes racemose-corymbose. Overall diam of heads to 2.5 cm, to tips of the phyllaries; involucre, when fresh, rather conoidal in shape (the base flat and the basal portion slightly broader than the top). Outer phyllaries lanceolate, 1 mm broad at base, green glabrous, mostly upward appressed, hooked. Inner phyllaries green, sometimes purplish, tapering to a more or less straight spiny tip; shorter than the corollas. Involucre contracted at the top when in fruit, seeds not falling out readily. Corollas 8-9 mm long, usually purple; tube 3.5-4 (—5) mm, lobes 1-1.5 mm. Anthers 3-4 mm long, apex apiculate. Pollen 3-pored, diam 45 μ m. Achenes 5-6 mm long, 2-2.5 mm broad.

Chromosome number. $2n = 32$ (Wulff 1937). $2n = 36$ (Tarnavaschi in Tischler 1950; Mulligan 1961).

Native distribution. Europe, excluding southern Italy; eastern Turkey to the Caspian Sea and thence northwest to Finland.

Canadian distribution. This is the commonest of the burdocks and the only one regarded as a serious weed. It occurs in generally dry soil, roadsides, wasteland, and pastures; it flowers from late July through August.

Arctium minus is found in every province.



Arctium. **a-c**, *A. minus*. **a**, habit, $\times \frac{1}{3}$; **b**, head, $\times 1$; **c**, achene, $\times 5$. **d-f**, *A. tomentosum*. **d**, head, $\times 1$; **e**, floret, $\times 4$; **f**, gland of corolla, $\times 200$. **g-h**, *A. lappa*. **g**, head, $\times 1$; **h**, habit, $\times \frac{1}{3}$. **i**, *A. nemorosum*, head, $\times 1$.

VARIATIONS

f. *laciniatum* Clute — some or all of the leaves narrow, laciniate.

f. *pallidum* Farw. — corollas white.

f. *purpureum* (Blytt) A.H. Evans — corollas deep purple.

The form *laciniatum* has been collected in Prince Edward Island, Quebec, and Ontario. The white-flowered form *pallidum* has been found in Prince Edward Island and Quebec.

The earliest collection seen in our study was made in 1878 at Fairmount, Ont. Rousseau (1968) stated that Holmes collected the species in 1821 at Montreal. In an 1860 survey around Prescott, Ont., B. Billings recorded that *Arctium lappa* (*Lappa major*) was "common" (Dore 1961). In a 1960 survey of the same area, Dore found only *A. minus*. Because the botanical work used by Billings (Gray's Manual, 2nd ed., 1858) lists only one species of *Arctium* (*Lappa major*), it is to be expected that Billings would identify his plant as this species. It may be concluded that *A. minus* was common in the Prescott area more than a century ago.

3. *A. lappa* L., Sp. Pl. 816. 1753.

Lappa major Gaertn., De fruct. et sem. II, 379. 1791.

Lappa officinalis All., Fl. ped. no. 528. 1785.

Lappa vulgaris Hill, Veg. Syst. IV, 28. 1762.

Arctium majus Bernh., Syst. Verz. Pfl. Erf. p. 154. 1800.

Arctium vulgare (Hill) Druse, Ann. Scott. Nat. Hist. no. 50, p. 222. 1906.

Complete synonymy is given by Arènes (1950, pp. 74-78).

Common name. Great burdock; grande bardane

Herb, 15-30 dm high; generally open in habit. Basal leaves to 60 × 50 cm, petioles solid. Inflorescence typically corymbose, although sometimes racemose-corymbose on lateral branches; peduncles to 10 cm long. Heads, when fresh, spheroidal in form but broader than high; involucre of fresh heads 3-3.5 cm broad, to tips of spines; to 4.5 cm broad when pressed. Outer phyllaries 1.5 mm broad at base, green, glabrous, rarely purplish, stiff, and spreading. Inner phyllaries tapering to a more or less straight spine, green or purplish tipped, equaling or exceeding the corollas in length. Fruiting heads 3.5 cm or more in diam, cup-shaped, open at top, seeds falling out readily. Corollas 10-11.5 mm long; tube 6-7 mm, tapering to the broader limb, lobes 2 mm, purple. Anthers 3.5-4.5 mm, tip acuminate, not generally apiculate. Pollen 3-pored, diam 45-48 μ m. Achenes 6-7 mm long, 2-3 mm broad.

Chromosome number. $n = 18$ (Nakajima 1936). $2n = 32$ (Sugiura 1931, 1936). $2n = 36$ (Löve and Löve 1944, as *A. vulgare*).

Native distribution. Southern Scandinavia, England, Scotland, Ireland; continental Europe except the Mediterranean regions of Spain and France and the Italian peninsula; Asia Minor and thence across Asia between latitudes 55° and 25°N, including Japan.

Canadian distribution. This is a common weed in wasteland, roadsides, and similar places, and is usually found in sandy clay or loam. It is less frequent than *A. minus*. Flowering takes place in the first half of August.

Arctium lappa has been collected at many localities in Nova Scotia, Quebec, and Ontario, and at several places in New Brunswick and Manitoba.

The involucre is purplish in the form *purpurascens* (Le Grand) Marsh. This form has been found in Quebec.

4. *A. nemorosum* Leg. in Court., Mag. d'Hort. 1:289. 1833.

Lappa nemorosa Koern., Schriften Königl. Phys.-Ökon. Ges. Königsberg 5:63. 1864.

Arctium majus ssp. *nemosum* (Lej.) Rouy, Fl. Fr. IX, 95. 1905.

Arctium minus ssp. *nemosum* (Lej.) Boswell Syme, Engl. Bot. 5:25. 1866.

Complete synonymy is given by Arènes (1950, pp. 96-98). Arènes regarded this taxon as a subspecies of *A. minus*, but most authors treat *nemosum* and *minus* as distinct species. We regard *A. nemorosum* as related more closely to *A. lappa* than to *A. minus* and therefore do not follow Arènes' treatment.

Herb, 13-15 dm, perhaps to 20 dm high, generally open in habit. Stems arching and usually dark-pigmented. Basal leaves about 45 × 40 cm, petioles hollow. Inflorescence typically racemose, occasionally corymbose-racemose. Heads, when fresh, rather spheroidal in shape, involucre 2.8-3.5 cm broad, to tip of the phyllaries (pressed heads 3-4 cm broad). Outer phyllaries 1 mm broad at base, green or purplish tinted, glabrous or arachnoid. Inner phyllaries longer, tapering to a straight or curved spiny tip, equaling or exceeding the corollas so that the flowers are scarcely visible. Fruiting heads 3.2 cm or more in width, involucre cup-shaped, open at the top. Corollas 9-10 mm long; tube 5-6 mm, tapering into the broader limb, lobes 1.5-2 mm, purple. Anthers 3-4 mm, tip apiculate. Pollen 3-pored, diam 44-47 μm. Achenes 6-8 mm long, 2.5-3 mm wide.

Chromosome number. $2n = 36$ (Moore 1968).

Native distribution. Scandinavia, Atlantic and central Europe (except Spain) to the Black Sea.

Canadian distribution. This species is not common, but has been found sporadically since the beginning of the present century. It has been collected in Newfoundland, Nova Scotia, Ontario, and Manitoba.

HYBRIDS

A. × *mixtum* Nym., Consp. Fl. Eur. Suppl. II, 179. 1889.

Hybrid between *A. minus* and *A. tomentosum*.

Some collections (DAO) from Lachine, Que., and from three counties of New Brunswick seem to be hybrids between these species. These plants have conspicuously arachnoid involucre but the phyllaries are narrower than in typical *A. tomentosum* and, in addition, are ascending-appressed rather than spreading-reflexed. The corollas of the suspected hybrids are glandular, as in *A. tomentosum*, but are somewhat shorter and the transition from the tube to the broader limb of the corolla is gradual, rather than abrupt. In *A. tomentosum*, the transition is abrupt. The smaller head size of these plants suggests that *A. minus* may be the other parent.

A. × *nothum* (Ruhm.) Weiss, in Hallier, Koch's Synopsis. II, p. 1512. 1902.

Hybrid between *A. lappa* and *A. minus*.

This hybrid was collected at Buckingham, Que., in 1923, together with one of the parents, *A. lappa* (CAN). The inflorescence of the hybrid is racemose-corymbose; heads are to 3.5 cm wide; the involucre green, glabrous, coarse and spreading — probably the florets do not exceed the inner phyllaries. The collector noted the probable hybrid nature of the plant.

A. minus var. *corymbosum* Wieg. was reported by Roland (1945) from Pictou, N.S. Descriptions of this variety suggest that it is intermediate between *A. lappa* and *A. minus* and possibly the variety may be a hybrid. The heads are intermediate in size and phyllary characters, and it resembles *A. lappa* in that the florets do not exceed the inner phyllaries.

PHYLOGENY OF THE GENUS

The genus *Arctium* is conveniently divided by the presence or absence of corolla glands, a seemingly natural separation. Beyond this point, there is disagreement among botanists. We regard the relative length of the corolla and the inner phyllaries as the character next in order of significance, and would place *A. lappa* and *A. nemorosum* together, rather than associating *A. nemorosum* with *A. minus*, as was done by Arènes. Other characters shared, to different degrees, by *A. lappa* and *A. nemorosum* support our choice.

Chromosome numbers provide no help in separating species or in understanding the phylogeny of the genus. Somatic counts of 32 and of 36 have been reported for the various species. We believe that the number in all taxa is $2n = 36$ and that the rather few counts of 32 are errors. The chromosomes are long and usually appear as an entangled group. The range in length within the karyome is wide. For both these reasons, errors in interpretation are easily made.

CIRSIUM True thistles, plumed thistles; chardon

Cirsium Miller, Gard. Dict. Abr. 4th ed. 1754, emend. Scop. Fl. Carn. 355. 1760.

Mostly biennial or perennial herbs of various habits; tall, branched, and spiny. Leaves alternate, usually pinnatifid, the margins spiny. Heads usually large, terminal on branches, many-flowered. Flowers all tubular, perfect (rarely dioecious); corolla consisting of a narrow tube and a broader 5-lobed limb; limb purple, reddish purple, yellow, or white. Receptacle densely covered with bristles or hairs. Achenes with terminal attachment, oblong, flattish; pappus deciduous, of numerous fine, soft, silky plumose setae united in a ring at their bases.

The genus *Cirsium* consists of probably 350 species distributed through the northern hemisphere of both the New and the Old worlds. Approximately 120 are native to North America, most occurring in the western United States. Fifteen species are found in Canada, three of these being introductions from the Old World. Two of these introductions are serious weeds — the only troublesome species of *Cirsium* in Canada.

Uses. The plumed thistles have not been used extensively for food or medicine. The heads of some Old World species have been used as a vegetable. One species (*C. oleraceum*) was used, especially in Russia, as a vegetable and also to ward off evil (Hegi 1929). Stalks of *C. palustre* are also edible (Sturtevant 1919). Various authors have reported that North American Indians used several native species of the western United States and adjacent Canada for food: *C. drummondii* (probably = *C. scariosum*) — stalks, roots; *C. eatoni* — stems; *C. scopulorum* — stalks and roots, raw or cooked; *C. undulatum* — stems, roots; *C. edule* — stems, roots; *C. occidentale* — roots; *C. hookerianum* — roots. Roots were usually boiled and used in soup. Of the above species, *C. edule*, *C. hookerianum*, and *C. undulatum* were used by Indians of British Columbia (see Yanovsky 1936). The introduced species have also been used by the Indians for medicinal purposes: *C. arvense* — infusion of root used for mouth diseases; *C. vulgare* (*lanceolatum*) — infusion of entire plant used for treatment of hemorrhoids, a use that originated in France (Rousseau and Raymond 1945).

KEY TO THE SPECIES

Heads small (to 2.5 cm high, involucre 1-2 cm high): introduced species.

Stems distinctly spiny-winged; flowers perfect. 1. *C. palustre*

Stems not conspicuously spiny-winged; flowers dioecious. 2. *C. arvense*

Heads large (2.5 cm or more, involucre 2 cm or more in height): native species, except *C. vulgare*.

A Upper surface of leaves rough, scabrous due to minute appressed spines. . 3. *C. vulgare*

A Upper surface of leaves not scabrous.

- B Pappus of mature seed longer than the corolla by 1-10 mm.4. *C. foliosum*
- B Pappus of seed shorter than the corolla.
 - C Heads large (5-7 cm high).
 - D Heads in a close terminal group surrounded and exceeded by the upper cauline leaves, or the plant stemless and the group of heads sessile amid the basal rosette; leaves generally oblanceolate, narrow, the length at least 5 times the width.5. *C. drummondii*
 - D Heads not compactly grouped nor enclosed by longer, upper cauline leaves; stem leaves elliptic-oblong in outline, broader, the length not more than 5 times the width.6. *C. pumilum* ssp. *hillii*
 - C Heads small (under 5 cm high).
 - E Involucre densely arachnoid, the outer phyllaries narrow (to 2 mm broad at base) lanceolate and tapering to a 1-2 mm spine.
 - F Corolla ochroleucous; involucreal phyllaries greenish7. *C. hookerianum*
 - F Corolla rose purple; outer involucreal phyllaries purplish.
 - G Styles extruded at least 4 mm beyond the corolla, corolla broad, anthers 6.5-9 mm long; achenes 5-6.5 mm long 8. *C. edule*
 - G Styles extruded no more than 1.5 mm beyond the corolla, corolla slender, anthers 3.5-4.5 mm long; achenes 4-4.5 mm long.9. *C. brevistylum*
(see also *C. × vancouverense*)
 - E Involucre not densely pubescent; outer phyllaries broader than 2 mm.
 - H Outer phyllaries eglandular, subequal in length; cauline leaves subentire to shallowly lobed.10. *C. scariosum*
 - H Outer phyllaries glandular, progressively longer from outer to inner; cauline leaves deeply pinnatifid lobed.
 - J Outer phyllaries tipped with only a short prickle; leaves green on both surfaces.11. *C. muticum*
 - J Outer phyllaries tipped with a distinct slender spine; leaves white tomentose below.
 - K Leaves green, glabrous above; stems lightly pilose, not conspicuously white-hairy.12. *C. discolor*
 - K Leaves grayish above; upper stems covered with fine white matted hairs.

- L Flowers ochroleucous; cauline leaves strongly decurrent and divided nearly to the midrib, the lobes linear, few, and remote. 13. *C. pitcheri*

- L Flowers purplish, rarely white; leaf bases merely clasping and not long decurrent, lobes broader.

- M Leaf lobes usually less than 7 mm broad; seedling rosette leaves entire or with remote lobes, greenish above; achenes to 5 mm long and with a conspicuous (0.5 mm) apical yellow band; corollas deep purple, rarely white; flowering season from early July to September. 14. *C. flodmanii*

- M Leaf lobes broader than 7 mm; seedling rosette leaves usually with overlapping lobes, densely tomentose and gray on both surfaces; achenes more than 5 mm long and with a very narrow yellow apical band or no band; corollas light purple; flowering season from mid-June to mid-July. 15. *C. undulatum*

1. *C. palustre* (L.) Scop., Fl. Carn. 2nd ed. II, 128. 1772.

Carduus palustris L., Sp. Pl. 822. 1753.

Cnicus palustris Willd., Fl. Berol. Prodr. 260. 1787.

Common names. Marsh plume thistle; cirse des marais

Biennial herb, 5-15 dm high. Stem slender, unbranched or the upper portion bearing a few divergent-ascending branches, soft, ridged, arachnoid (long multicellular hairs), strongly spiny-winged from the decurrent leaf bases. Branches terminated by a small compact cluster of heads. Rosette and the lower cauline leaves narrowly elliptic, numerous; upper leaves lanceolate, usually few and remote. Leaves pinnatifid, segmented to about half the width of the blade; segments narrow, spine-tipped, separated by rather broad sinuses; marginal spines slender, stiff, to 6 mm long. Leaf bases decurrent, forming very spiny longitudinal bands of tissue. Leaves subcoriaceous, glabrate to lightly pilose above; lightly to densely villous below (long multicellular hairs) and with prominent woody veins. Heads 1.5-1.8 cm high, about one-third as wide; involucre ovoid, 1-1.5 cm high. Outer phyllaries ovate-lanceolate, about 1.5 mm broad, soft, green and often purple-tinged, lightly to heavily arachnoid, tip dark glutinous; apex usually bearing a sharp, thick, frequently curved 0.5-1 mm spine but sometimes merely pointed. Inner phyllaries progressively longer; innermost unarmed, tips flat, pointed. Corollas purple, 11-12 mm long; tube 5.5-6 mm, lobes 3.5-4 mm. Pappus about 9 mm long; 10 mm, tawny, when mature. Anthers 4-4.5 mm long. Pollen tricolporate, $38 \times 44 \mu\text{m}$; polar diam $44 \mu\text{m}$; exine coarsely spiny, spines about $5 \mu\text{m}$ high,

6 μm broad at base, wall about 3 μm thick, excluding spines. Stigma joint about 2 mm from tip. Achenes 2.5-3.5 mm long, 1 mm broad, straw-colored, almost white, with shiny apical collar.

Chromosome number. $2n = 34$ (Poddubnaja-Arnoldi 1931; Czapik 1958; Moore and Frankton 1962a; Gadella and Kliphuis 1963, 1966).

Native distribution. Europe (Scandinavia, Atlantic and central Europe and the western Mediterranean region).

Canadian distribution. This rather rare introduced thistle is known from Newfoundland, Nova Scotia, and British Columbia. A report from New Brunswick has been found to be erroneous. *Cirsium palustre* is found in moist woodland. Early collectors thought that the species was possibly indigenous in eastern North America, because it was found in habitats where it appeared to be native.

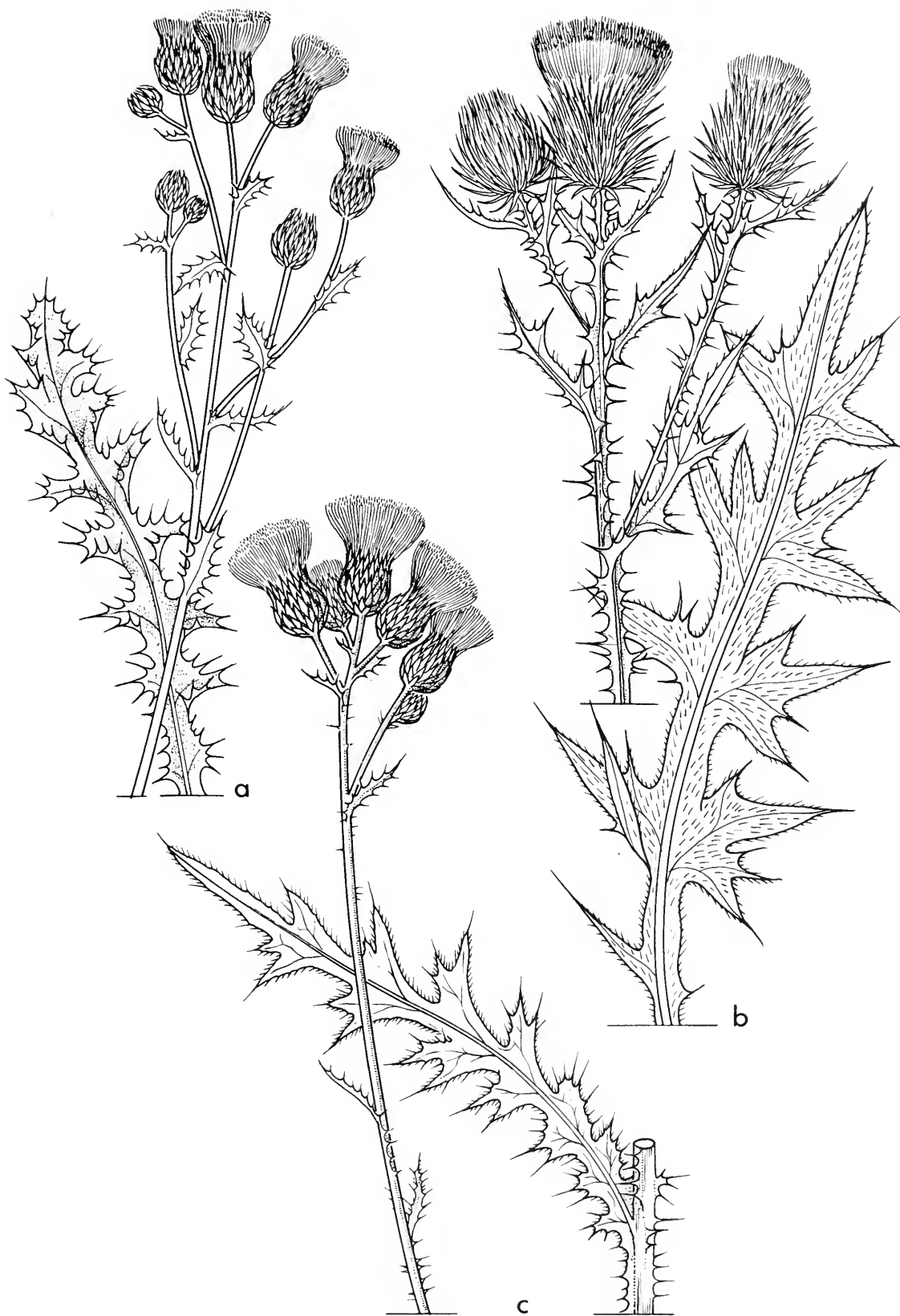
It was collected in New Hampshire in 1902 (Holt 1902) and in Newfoundland in 1910 (Fernald 1933). It has been known in Michigan since 1935 and in Wisconsin since 1961 (Johnson and Iltis 1962).

2. *C. arvense* (L.) Scop., Fl. Carn. 2nd ed. II, 126. 1772.

Serratula arvensis L., Sp. Pl. 820. 1753.

Common names. Canada thistle, field thistle, creeping thistle; chardon du Canada, chardon des champs, cirse des champs

Perennial herb, usually 3-9 dm high, but sometimes to 15 dm. Stems slender, leafy, branched, the branches terminated by 1-5 more or less sessile heads. Plants spreading rapidly by horizontal lateral roots from which arise aerial shoots. Leaves generally oblong in outline, the length 3-5 times the width; entire to deeply pinnately lobed, variable in segmentation, texture, and spininess, according to the variety. Leaves sessile, clasping, sometimes shortly decurrent; the upper surface glabrous, lower surface glabrous or lightly arachnoid or tomentose, in the different varieties. Leaf margins bearing short, fine spines or long, strong spines, in varying abundance. Plants dioecious; female flowers may contain vestigial anthers and male flowers may contain female parts, often apparently normal, but with only a vestigial ovary. Heads 15-25 mm high and one-third to one-quarter as wide. Involucre 10-20 mm high, ovoid cylindric. Male heads often slightly smaller than the female. Outer phyllaries ovate, tough-textured, subulate-tipped (0.5-0.75 mm stout spine), glabrous or lightly arachnoid on the surface and margins, with a narrow glandular line. Inner phyllaries progressively longer and lanceolate; innermost phyllaries unarmed, the tips flat and pointed, chartaceous and sometimes erose and purplish. Flowers of female heads 23-26 mm long; tube long and slender, 20-23 mm, lobes of the short spreading limb about 2 mm.



Cirsium. a, *C. arvense*, habit, $\times \frac{2}{3}$. b, *C. vulgare*, habit and lower leaf, $\times \frac{1}{5}$. c, *C. palustre*, habit and lower leaf, $\times \frac{2}{3}$.

Pistil well-developed, stigma 1.5-2 mm; anthers absent or vestigial and without pollen. Pappus about 14 mm long in fresh flowers, becoming 20-30 mm long when in fruit, exceeding the floret, tawny in color. Florets of male heads 12-14 mm long; tube 7-8.5 mm, lobes 3-4 mm. Anthers 4 mm; pollen 42-48 μ m diam, tricolporate, exine spiny, spines usually 4-5 μ m high and 4-5 μ m broad at the base and crowded, occasionally smaller, 2×3 μ m and fewer in number. Pistil absent, or present and apparently normal but ovary vestigial. Male flowers occasionally have functional female parts and set seed. In some genotypes, environmental factors may determine the degree of development of the organs. Achenes 2.5-4 mm long, 1 mm wide, straw or light brown in color.

Botanists usually recognize three or four infraspecific entities in this polymorphic species: for example, the typical and three varieties, *mite*, *integrifolium*, and *vestitum* (Fernald 1950). The recent treatment by Charadze in the Flora of the U.S.S.R. (1963) raised these varieties to specific rank as *C. arvense* (including var. *mite*), *C. setosum* (var. *integrifolium*), and *C. incanum* (var. *vestitum*).

We believe that the various morphological variants interbreed freely and that the differences are adequately recognized at the varietal level.

Cronquist (1955) has selected the type specimen in referring to "the original of Linnaeus," presumably meaning a specimen in the Linnaean Herbarium, London. He pointed out that the specimen belonged to the rarer phase now called the variety *mite* and that the commoner plants regarded as typical could be called the variety *horridum*. Gleason and Cronquist (1963) retained this concept. We consider Specimen 965.19 in the Linnean Herbarium, London, to be the type specimen of *C. arvense* and agree with Cronquist that it falls in the variety formerly called *mite*. Consequently it is necessary to designate these plants as the typical variety, *arvense*, and refer our commonest plants to the variety *horridum*.

Native distribution. *Cirsium arvense* s. lat. is native to the Old World; all Europe, North Africa, Asia Minor, Afghanistan, Siberia, China, Japan. Charadze (1963) indicates that there is some geographic separation of the variants. He points out that the entire-leaved plants are mainly Asiatic.

KEY TO THE VARIETIES

Leaves gray tomentose below.....var. *vestitum*

Leaves glabrous or only lightly arachnoid below.

Leaves thin, flat, marginal spines few, fine and short.

Leaves all entire or the upper leaves entire and the lower stem leaves shallowly and regularly pinnatifid or undulating.....var. *integrifolium*

Leaves shallowly to deeply pinnatifid, often asymmetrical. var. *arvense*

Leaves thick, subcoriaceous, the surface wavy, marginal spines numerous, stout and long. var. *horridum*

var. *vestitum* Wimm. & Grab., Fl. Siles. III, 82. 1829. (*C. incanum* S.G. Gmel. Fisch. ex MB.). Stem and flower peduncles tomentose; leaves gray tomentose below, usually entire or shallowly pinnatifid, flat; spines weak.

var. *integrifolium* Wimm. & Grab., Fl. Siles. III, 82. 1829. (*C. setosum* (Willd.) MB.). Leaves thin and flat, usually oblong or elliptic in outline; all leaves entire or the upper, smaller leaves entire and the lower leaves shallowly and symmetrically pinnatifid, or undulating; spines few and fine, to 3 mm long.

var. *arvense* (var. *mite* Wimm. & Grab., Fl. Siles. III, 82. 1829). Upper leaves elliptic to oblong, subentire or entire; lower stem leaves elliptic to oblanceolate, shallowly pinnatifid to deeply and often irregularly segmented and often with few remote lobes of unequal length; marginal spines few, fine, to 3 mm long.

var. *horridum* Wimm. & Grab., Fl. Siles. III, 82. 1829. (typical *C. arvense*, sensu Fernald 1950). Leaves of rather tough texture, stiff, the surface wavy, not flat, deeply and symmetrically lobed, lobes pointed; marginal spines numerous, stiff and stout, yellow, longer than in the other varieties.

Chromosome number. (as *C. arvense* s. lat. $2n = 34$ (Ehrenberg 1945; Gadella and Kliphuis 1963).

var. *horridum*: $2n = 34$ (Czapik 1958 — a tetraploid seedling also was reported but the author doubted that it would survive).

var. *arvense*: $2n = 34$ (Czapik 1958 — as var. *mite*; Moore 1968).

var. *vestitum*: $2n = 34$ (Moore 1968).

var. *integrifolium*: $2n = 34$ (Moore & Frankton 1962 — as var. *mite*, specimen now revised to var. *integrifolium*).

Native distribution. All Europe and North Africa, extending at least to central Asia. It occurs also in northern China and Japan. The species has been introduced so extensively that it is difficult to distinguish the limit of original native range.

Canadian distribution. This species is found in the agricultural areas of all the provinces. The variety *horridum* is the commonest and is the weed known to most persons. The other varieties may be expected to occur in similar locations. Collections are known from the following provinces:

var. *arvense* — N.S., Que., Ont., Man.

var. *integrifolium* — Que., Ont., Man., Sask., Alta., B.C.

var. *vestitum* — Que., Ont., Man., Sask.

White-flowered plants, forma *albiflorum* (Rand. & Redf.) R. Hoffm., of the var. *horridum* have been collected in all the provinces. A form, f. *rubricaule* Lepage, with red-pigmented involucre and stem has been described from northern Ontario.

Canada thistle is also a very serious weed in the United States north of approximately latitude 37°N. It is troublesome in the eastern states (west to longitude 97°W) and in the Pacific states, but does not survive in the more southerly states.

Apparently *Cirsium arvense* reached North America early and was well established by the second half of the eighteenth century. It is thought that seed was brought in as an impurity in farm seed, probably in both the English and the French colonies (Hansen 1918). The first legislation to control the weed was passed by Vermont in 1795; other states later took similar action. Rousseau (1968) states that *C. arvense* was collected at Montreal in 1821 and was then common.

The weedy nature of the plant is due mainly to its method of vegetative propagation. Lateral roots extend horizontally and produce buds from which aerial shoots develop. The vertical roots often penetrate to depths of 2-3 m, even to 5 m in certain soils, and the horizontal roots can spread radially as much as 6-12 m in a season (Salisbury 1961, pp. 213-215). Most of the horizontal roots lie 3-6 dm below the surface and are usually unharmed by shallow cultivation. Moreover, if the roots are cut by cultivation, segments can survive and quickly produce new plants. Canada thistle grows in a wide range of soils, even in areas containing up to 2% of salt.

3. *C. vulgare* (Savi) Ten., Fl. Nap. V, 209. 1835-36.

Carduus lanceolatus L., Sp. Pl. 821. 1753.

Ascalea lanceolata (L.) Hill, Herb. Brit. I, 72. 1769.

Cirsium lanceolatum of various authors, but not Hill, Herb. Brit. I, 80. 1769. (nom. illegit.)

Cirsium lanceolatum (L.) Scop., Fl. Carn. 2nd ed. II, 130. 1772.

Cnicus lanceolatus (L.) Willd., Fl. Berol. Prodr. 259. 1787.

Carduus vulgaris Savi, Fl. Pis. II, 241. 1798.

Cirsium vulgare (Savi) Airy-Shaw, Feddes Repert. 43:304. 1938.

Additional synonyms are listed by Charadze (1963).

This species was long known as *Cirsium lanceolatum*, a name often attributed to Hill. However, Hill's species is actually *Cirsium dissectum*, and *Cirsium lanceolatum* Hill renders *Cirsium lanceolatum* (L.) Scop. illegitimate as a later homonym, as Airy-Shaw

has pointed out in making the combination *Cirsium vulgare* (Savi) Airy-Shaw. This combination had previously been made by Tenore and Tenore's name has priority.

Common names. Bull thistle, common thistle, spear thistle; gros chardon, chardon vulgaire, chardon lancéolé

Biennial herb, usually 5-15 dm, sometimes to 30 dm high, bearing many spreading branches; some forms less branched, the branches strictly ascending. Stem woody, ridged, lightly arachnoid; at least the upper branches irregularly and spiny winged; branches usually bearing a single large head. Leaves large, oblong-lanceolate to obovate (lower cauline to 35×10 cm), deeply pinnately parted, the segments generally lanceolate, ending in a long, stout (to 1 cm) spine, margins bearing shorter, finer spines; leaves coriaceous, upper surface glabrous, bearing short appressed stiff prickles, lower surface glabrate to gray tomentose, with matted fine long hairs; veins woody and prominent. Plants with less deeply divided leaves of softer texture, woolly below and with smaller spines occasionally found. Bases of leaves, especially the upper leaves, clasping-decurrent, forming stem wings. Heads 3-4 cm high, width about three-quarters the height; involucre ovoid to subglobose, 2-5.3.5 cm high. Phyllaries numerous, crowded, narrow, eglandular, stiff, green, spreading, arachnoid on surface and margins. Outer phyllaries 1-2 mm broad at base, lanceolate, with a prominent woody midrib, which terminates as a 2-4 mm strong, yellow spine. Inner phyllaries progressively longer, linear; innermost phyllaries ending in a stiff point but not a true spine. Flowers purple, rarely white. Corollas 32-34 mm long; tube 20-25 mm, lobes 5-7 mm. Pappus 20-26 mm long. Anthers 7-8 mm long. Pollen tricolporate, polar diam $50 \mu\text{m}$; exine spiny, spines ca. $3 \mu\text{m}$ long, $3 \mu\text{m}$ wide at base, numerous, crowded. Achenes 3-4 mm long, 1.3-1.5 mm wide; glossy light brown with fine darker longitudinal striae.

Chromosome number. $2n = 68$ (Poddubnaja-Arnoldi 1931; Löve and Löve 1944; Czapik 1958; Moore and Frankton 1962a; Gadella and Kliphuis 1966).

Native distribution. Europe, Mediterranean, Balkans, Asia Minor, Turkish Armenia, Kurdistan, Iran, Chinese Turkestan.

Canadian distribution. Bull thistle is a common weed and is abundant in Quebec, Ontario, and southern British Columbia. It is known from all provinces, but is less abundant on the Prairies, especially in Manitoba and Saskatchewan. Because it propagates only by seed and does not withstand cultivation, it is less troublesome than *C. arvense*. Bull thistle is found along roadsides, in pastures and in waste places; it flowers from July through September.

The white-flowered plant is rare; we have seen only one collection (British Columbia).

Tall arborescent plants (3-4 m) with a single stem and numerous ascending lateral branches are sometimes seen, sometimes in the same field with the more typical, lower, many-stemmed plants. Tall plants with fewer and

ascending branches and softer, less spiny leaves were called ssp. *hypoleucum* (DC.) Beger by Hegi (1929), who treated the species as *C. lanceolatum*. Hegi stated that the distribution of the subspecies was insufficiently known. At specific rank, the tall plants are known as *C. silvaticum* Tausch. Charadze (loc. cit.) placed all these taxa in synonymy of *C. vulgare* and recognized no infraspecific taxa and we follow this author. We are not certain that the tall plants in Canada match fully the description of ssp. *hypoleucum*; moreover, our plants have probably crossed here with other strains of the species and are no longer genetically identical with European populations.

It is probable that *C. vulgare* was introduced to North America in colonial times. Rousseau (1968) stated that the species was collected in 1821 at Montreal, where it was common.

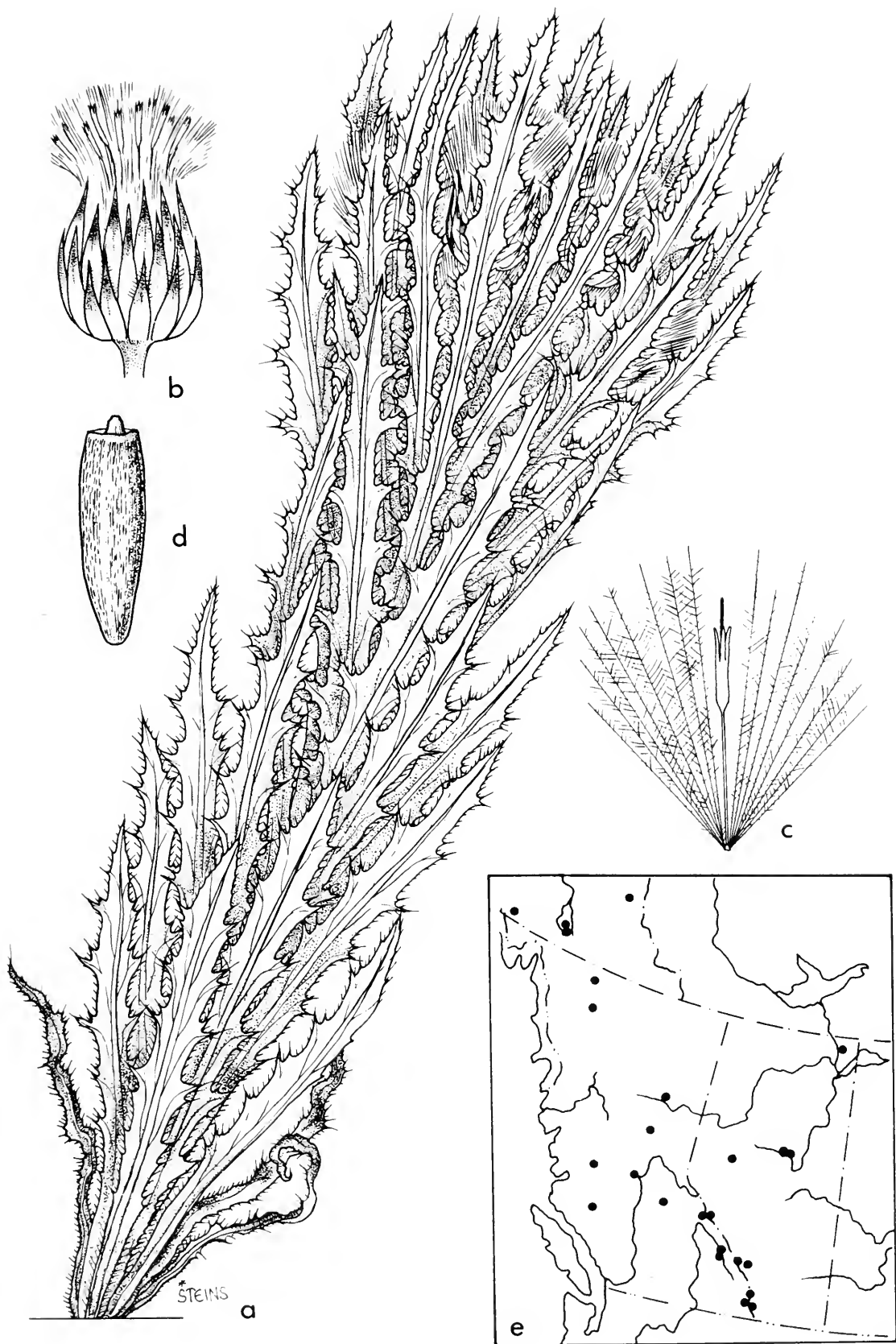
4. *C. foliosum* (Hook.) DC., Prodr. VI, 654. 1837.

Carduus foliosus Hooker, Fl. Bor. Am. I, 303. 1833.

Cnicus foliosus A. Gray, Proc. Am. Acad. 10:423. 1874.

Biennial herb, 25-70 cm high. Stem unbranched, thick and fleshy, ribbed, pilose, bearing numerous (40-70) ascending leaves that exceed the compact terminal cluster of heads (5 or more) by up to 10 cm. Leaves linear-oblongate, apex acute, base tapering, larger leaves to 18 cm long, 2 cm broad, remotely and shallowly lobed, lobes ovate, marginal spines thin, to 3 mm long. Leaves thin, veins broad and fleshy, upper surface bearing multicellular hairs; pubescence of lower surface variable — lightly tomentose, wefts of narrow hairs on blade and multicellular broad hairs on midrib or sometimes villous and consisting mainly of broad multicellular hairs on blade and vein. Heads 3-4 cm high, the width about three-quarters the height; involucre about 2 cm high, lightly pubescent, consisting of 4-5 rows of appressed phyllaries. Outer phyllaries lanceolate or ovate-lanceolate, 2-4 mm broad at base, thin, membranous, tapering to a slender 2-3 mm spine; surface glabrate, with marginal multicellular hairs, eglandular but occasionally with a dark midline. Phyllaries olive green in color, usually subequal in length but sometimes progressively longer from outer to inner. Innermost phyllaries unarmed, the tips pointed and sometimes slightly erose. Flowers white, occasionally pale pink. Corollas 21.5-25 mm long, very slender; tube 12-14 mm, lobes 3-4 mm; pappus exceeding the florets, 23-29 mm long, of about 60 tawny setae. Anthers 4.5-5.5 mm long. Pollen tricolporate, exine spiny, spines about 3 μ m high, 3 μ m broad at base; polar diam of grains 38-44 μ m. Achenes 4-5.5 mm, usually 4.5 mm long, 1.2-1.7 mm broad; light brown with fine, darker striae and a narrow yellowish apical rim.

Chromosome number. $2n = 34$ (Moore and Frankton 1964). Ownbey and Hsi (1963) reported somatic counts of 34 and 36?. They note, however, that one of the collections counted is a segregate species (*C. kelseyi*), which we now place in *C. scariosum*. It is possible that all the collections counted by Ownbey and



Cirsium foliosum. a, habit, $\times \frac{1}{2}$; b, head, $\times 1$; c, floret with pappus, $\times 1\frac{1}{2}$; d, achene, $\times 6$; e, distribution.

Hsi should be referred to *C. scariosum*. The presence of accessory chromosomes is suggested by their report of 36? chromosomes.

Native distribution. Western Canada and northwestern United States.

Canadian distribution. *Cirsium foliosum* is found in Alberta, British Columbia, and the Yukon Territory, north to at least latitude 63°N. It seems to have spread north along the mountains and, later, in Alberta, into lower grassland and forest regions. Plants are found in moist areas, in subalpine meadows, and in openings in birch – willow thickets, and are common but not abundant. In Canada, collections have been made at elevations to 1,700 m.

In the United States *C. foliosum* is known only from the adjacent northwestern states (Wyoming and probably Montana). The name has been incorrectly applied in the literature to several species of the western states, as far south as California.

5. *C. drummondii* T. & G., Fl. N. Am. II, 3, 459. 1843.

Carduus pumilus Hooker, Fl. Bor. Am. I, 302. 1833., *non* Nuttall (*Cnicus pumilus* Nutt.)

Cnicus drummondii Gray, Proc. Am. Acad. 10:40. 1874.

Cirsium coccinatum Osterhout, Torreya 34:45. 1934.

Common name. Drummond's thistle

Biennial herb, usually 15-30 cm high but sometimes acaulescent and occasionally reaching 11 dm in height. Stem unbranched, thick, fleshy, green, tomentose (broad multicellular hairs). Upper cauline leaves numerous, ascending, enclosing a compact group (1-(3-5)-9) of sessile heads. Leaves narrowly oblanceolate, the length at least 5 times the width, usually deeply lobed to half or three-quarters the width of the blade, the segments oblong-triangular, with 3-5 mm slender marginal spines, the upper surface glabrous to pilose, green, lower surface lighter in color, lightly and unevenly pubescent due to a mixture of broad, multicellular hairs and narrow 2-3 celled hairs. Heads 5-6 cm high, almost as broad; involucre 3-3.5 cm. Outer phyllaries ovate, 5-8 mm broad at base, glandular, glabrous, bearing a slender 2-3 mm spine. Phyllaries progressively longer toward the interior, spines appressed. Inner phyllaries narrow, the apex broadly dilated, chartaceous, erose. Flowers rose purple. Corollas 30-44 mm long; tube 20-30 mm, lobes 5-7 mm; the pappus shorter than the corolla by 1-8 mm, of 45-50 white setae, setae yellowish on the mature achenes. Anthers 7-9 mm long. Pollen tricolporate, exine echinate, spines 4-5 μ m high, polar diam 55-65 μ m. Achenes 4-5.5 mm long, 1.3-1.5 mm broad, straw-colored with a light yellow apical rim.

Chromosome number. $2n = 34$ (Ownbey and Hsi 1963; Moore and Frankton 1964).



Cirsium. a-d, *C. pumilum* ssp. *hillii*. a, habit, $\times \frac{1}{2}$; b, phyllaries, $\times 1\frac{1}{2}$; c, achene, $\times 6$; d, distribution. e-h, *C. drummondii*. e, habit, $\times \frac{1}{2}$; f, phyllaries, $\times 1\frac{1}{2}$; g, achene, $\times 6$; h, distribution.

Native distribution. Western Canada and northwestern United States.

Canadian distribution. This species is found in the Northwest Territories to latitude 50°N and in British Columbia, Alberta, Saskatchewan, Manitoba, and northern Ontario. It has been collected in the margins or openings of deciduous woods at elevations to 600 m. In the prairies, *C. drummondii* is found in meadows, grassland, and roadsides. It is a widespread but not abundant plant. Among specimens seen, acaulescent plants were mainly from the foothills of the Rockies, in Alberta. The acaulescent plants have often been called var. *acaulescens* (Gray) Macbr.; this name does not apply to our species but to a different species found in the United States. No infraspecific designation is available for our acaulescent plants; this variant may not deserve taxonomic recognition.

In the United States, typical *C. drummondii* is known to us only from Wyoming and South Dakota, but it may also occur in the adjacent northerly states. It appears that the plants spread into Canada along the mountains and, later, eastward across the prairies to the northern shore of Lake Superior. The closely related species, *C. pumilum*, probably arose at the same center of origin and spread eastward, south of the Great Lakes to the Atlantic coast.

6. *C. pumilum* ssp. *hillii* (Canby) Moore & Frankton, Can. J. Bot. 44:588. 1966.

Cnicus hillii Canby, Gard. For. 4:101. 1891.

Carduus hillii (Canby) Porter, Mem. Torrey Bot. Cl. 5:344. 1894.

Cirsium hillii (Canby) Fern., Rhodora 10:95. 1908.

Cirsium pumilum var. *hillii* (Canby) Boivin, Nat. Can. 94:646. 1967.

Common name. Hill's thistle

Perennial herb, 25-60 cm high, having a deep taproot, which usually shows a distinct tuberous swelling. Stems soft, often thick at the base, ridged, sparsely pubescent or tomentose, with both broad multicellular hairs and narrow hairs consisting of a single long apical cell and a few short basal cells; stem simple or with 1-2 short branches near the top, terminated by a single large flower head. Leaves mainly basal, the lower cauline leaves forming a rosette from which the stem arises, bearing few, progressively smaller leaves. Leaves elliptic-oblong, base tapering, sometimes clasping, margin undulating or shallowly pinnatifid, rarely deeply lobed, with fine marginal spines 3-6 mm long, leaf texture thin, pubescence varying from glabrate on both surfaces to pilose above, villous below. Heads 4-7 cm high, usually 5-6 cm, 3-5 cm broad; involucre 3-3.5 cm high, ovoid, sometimes with several leaves closely investing the head. Involucre composed of about 8 spiral rows of progressively longer phyllaries. Outer phyllaries 3-6 mm broad at the base, ovate, tapering to a narrow point, tipped by a slender 1.5-3 mm appressed spine, strongly

glandular; tips of innermost phyllaries tapering or slightly dilated, chartaceous, curled. Corollas rose purple, 43-60 mm, usually 45-55 mm, long; tube 25-35 mm, throat 10-16 mm, lobes 6-9 mm. Pappus 6-12 mm shorter than the corolla, of 55-70 white setae. Anthers 8-11 mm, usually 9-10 mm, long; pollen tricolporate, diam 60-70 μ m. Achenes 4.5-5 \times 1.5-1.8 mm, straw or light brown, sometimes with darker striae, with a yellow apical band, 0.2-0.5 mm wide.

Chromosome number. $2n = 30$ (Ownbey and Hsi 1963, as *C. hillii*; Moore and Frankton 1966).

Native distribution. North-central United States (south of Lake Superior to Lake Erie) and the Georgian Bay area of Ontario.

Canadian distribution. This plant has been collected only in Ontario, in the Lake Huron – Georgian Bay area (Manitoulin Island, Bruce Co., Simcoe Co.). It was reported from Squirrel Island, in Lake St. Clair, early in the present century by Dodge (1914). No collections from the latter area have been seen but it is possible that the plant did occur there earlier and has since become extinct. Its occurrence there would not conflict with the presently known distribution and would be of phytogeographic interest.

This thistle is found in sandy or dry prairie habitats, flowering in Ontario from mid-July through August.

A white-flowered variant has been named forma *candidum* Boivin, from a collection made in 1874 on the shores of Lake Huron.

Our plants are the most northerly representatives of the subspecies, the main range of which lies in the United States (Wisconsin, Iowa, and east to western New York). Farther east, the subspecies *hillii* is replaced by the subspecies *pumilum*. The two subspecies have usually been treated as separate species, but we consider that they are so similar that recognition as subspecies is adequate.

7. *C. hookerianum* Nutt., Trans. Am. Phil. Soc. 7:418. 1841.

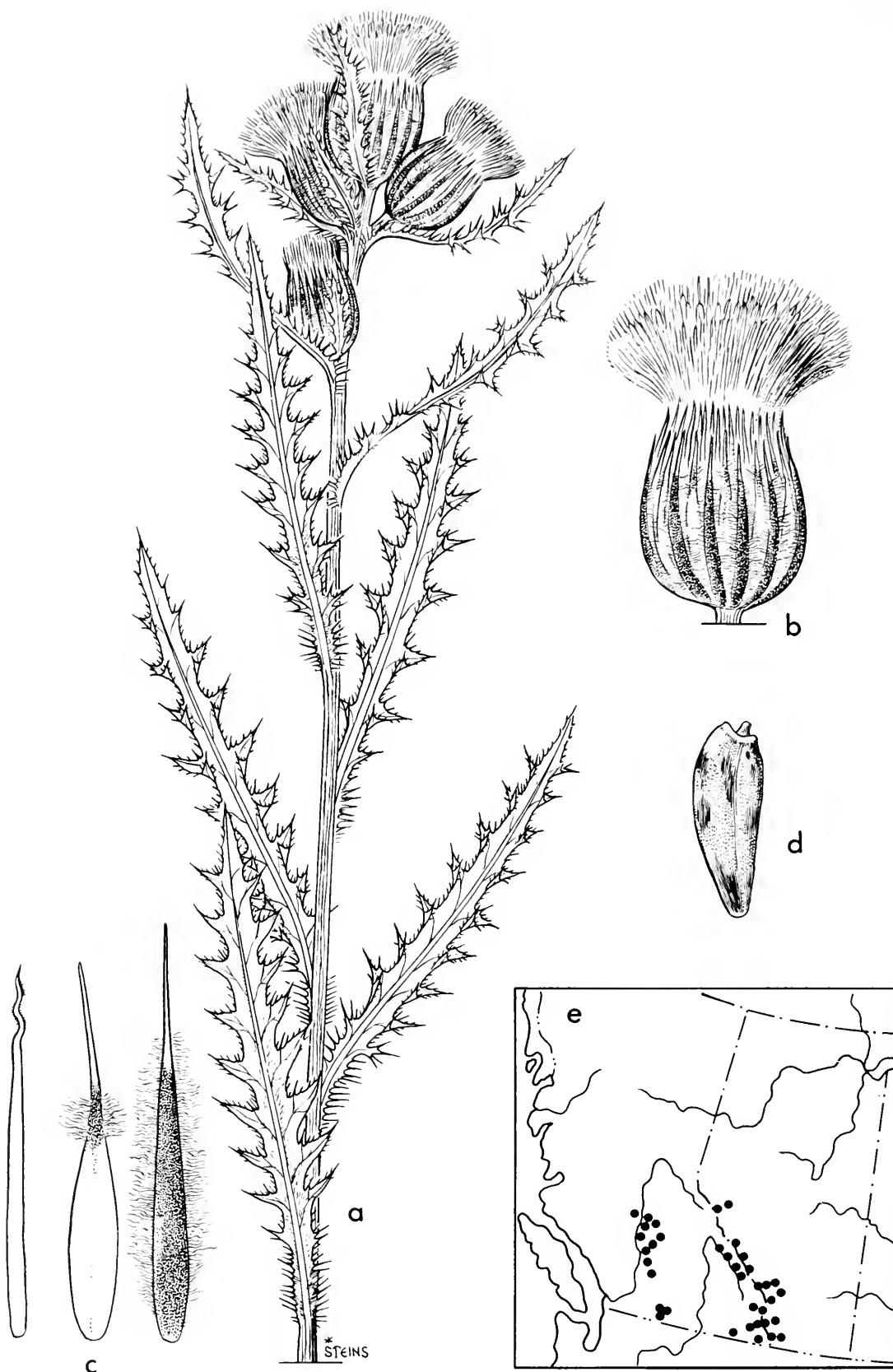
Carduus discolor var. *floribus albis* Hooker, Fl. Bor. Am. I, 302. 1833.

Cnicus hookerianus Gray, Proc. Am. Acad. 10:46. 1874.

Carduus hookerianus (Nutt.) Heller, Cat. N. Am. Pl. 7 1898; Rydb., Cat. Fl. Mont., Mem. N.Y. Bot. Gard. 1:448. 1910.

Common name. White thistle

Biennial herb 25-75 cm in height, with a deep, slender taproot. Stem usually simple with a terminal cluster (1-6) of heads, but sometimes branched and each branch bearing 1-few heads; stem thin below the heads but the basal portion thick and hollow; ribbed, brownish, sericeous, with long, thin,



Cirsium hookerianum. a, habit, $\times \frac{1}{2}$; b, head, $\times 1$; c, phyllaries (inner, mid, outer), $\times \frac{1}{2}$; d, achene, $\times 4$; e, distribution.

multicellular hairs. Rosette leaves narrowly oblanceolate, entire, base tapering, subentire or pinnately lobed to half the width of the blade; lobes regular, triangular-lanceolate; leaves green above, white woolly below. Stem leaves narrow, elliptic-oblong, base tapering, clasping and sometimes shortly decurrent, to 20×3 cm, subentire or undulant but usually shallowly pinnately lobed, sometimes to half the width of the blade; lobes numerous, symmetrical, triangular or lanceolate; marginal spines few and weak on subentire leaves but more numerous and larger, to 5 mm, on lobed leaves. Midribs broad, upper surface of leaves green, lightly sericeous (multicellular hairs); lower surface densely tomentose, with chiefly long matted hairs consisting of a long apical cell and a few short basal cells and also some multicellular hairs on the veins; the degree of pubescence variable from one plant to the next, leaves sometimes merely glabrate above and lightly tomentose below. Heads 3-4 cm high; involucre 2-2.5 cm high, densely tomentose, of about 6 rows of loosely arranged phyllaries, either subequal in length or irregularly longer from outer to inner. Outermost phyllaries sometimes unlike those within, narrower (1.5 mm) linear-lanceolate, darker in color, tapering to a lighter spiny tip. Mid phyllaries broader (2 mm), lanceolate, terminated by a strong 3-5 mm yellow spine. Heavy pubescence of mainly multicellular hairs borne on exposed portions of margins of the outer phyllaries, the hairs extending laterally to adjacent phyllaries. Phyllaries eglandular but often with a dark midline. Innermost phyllaries longer and narrower, without terminal spine, the tip pointed, thin and membranous, pubescent on exposed portions and often with a dark midline. Flowers white or creamy white, very rarely pinkish. Corollas usually 20-26 mm long, but rarely to 37 mm; tube 10-12 mm, throat 6-8 mm, lobes 4-6 mm. Pappus 3-5 mm shorter than the corolla, of 40-55 white setae. Anthers usually 7-9 mm long, rarely to 11 mm; anther filaments brown and densely hairy. Pollen diam $50-55 \mu\text{m}$. Achenes $5-6.5 \times 1.5-2.2$ mm, solid brown or brown with lighter striae, sometimes with a yellowish band (to 0.3 mm wide) at the apical end but sometimes lacking this and only the rim of different color or texture.

Intraspecific variation. There is a moderate degree of variation within this species in Canada. Variation is evident in the degree of lobing of the leaves, the abundance and size of the leaf spines, the amount of leaf pubescence, and the general plant habit — branched or unbranched. On unbranched plants, the heads are sessile and borne in compact groups along the stem; on branched plants, one to several heads are borne at the tip of each branch. Our plants usually have shallowly lobed, moderately spiny leaves but extremes in both characters are found. Typical plants of this species are found only in the northern parts of the adjacent states; farther south, the plants tend to have more deeply and irregularly lobed leaves and many specimens approach, morphologically, another species of the area and present difficulty in classification. On the whole, the Canadian population is a more homogeneous systematic unit than that of the United States.

Native distribution. Southern Alberta and British Columbia and northern parts of adjacent states.

Canadian distribution. British Columbia and the western margin of Alberta, north to approximately latitude 53°N. In British Columbia, the distribution is bilobed; the western lobe occupies the Cascade and Coast Ranges and the eastern lobe lies in the Columbia Mountains, the Rocky Mountains, and the foothills of the Rockies in Alberta. The two areas are separated by the Kamloops Plateau in central British Columbia. The species is common but not abundant in meadows, grassland, forest openings, and roadsides, at elevations of 600 to 2,100 m; it flowers from early July to mid-September.

8. *C. edule* Nutt., Trans. Am. Phil. Soc. 7:120. 1840.

Cnicus edulis (Nutt.) Gray, Proc. Am. Acad. 10:47. 1874.

Carduus edulis (Nutt.) Greene, Proc. Acad. Phila. 1892: 362. 1893.

Carduus macounii Greene, Ottawa Nat. 16:38. 1902.

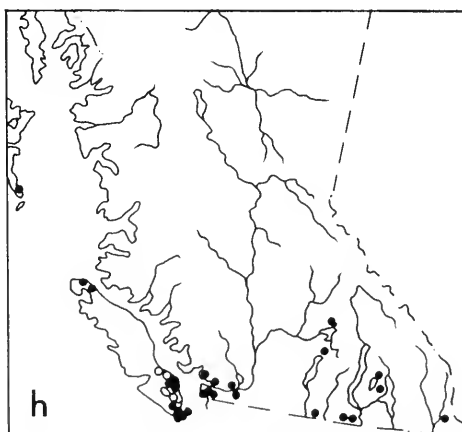
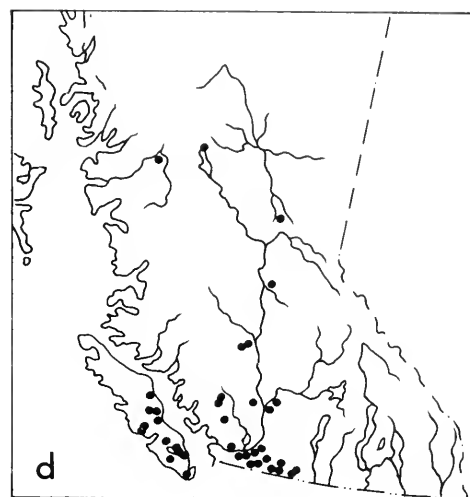
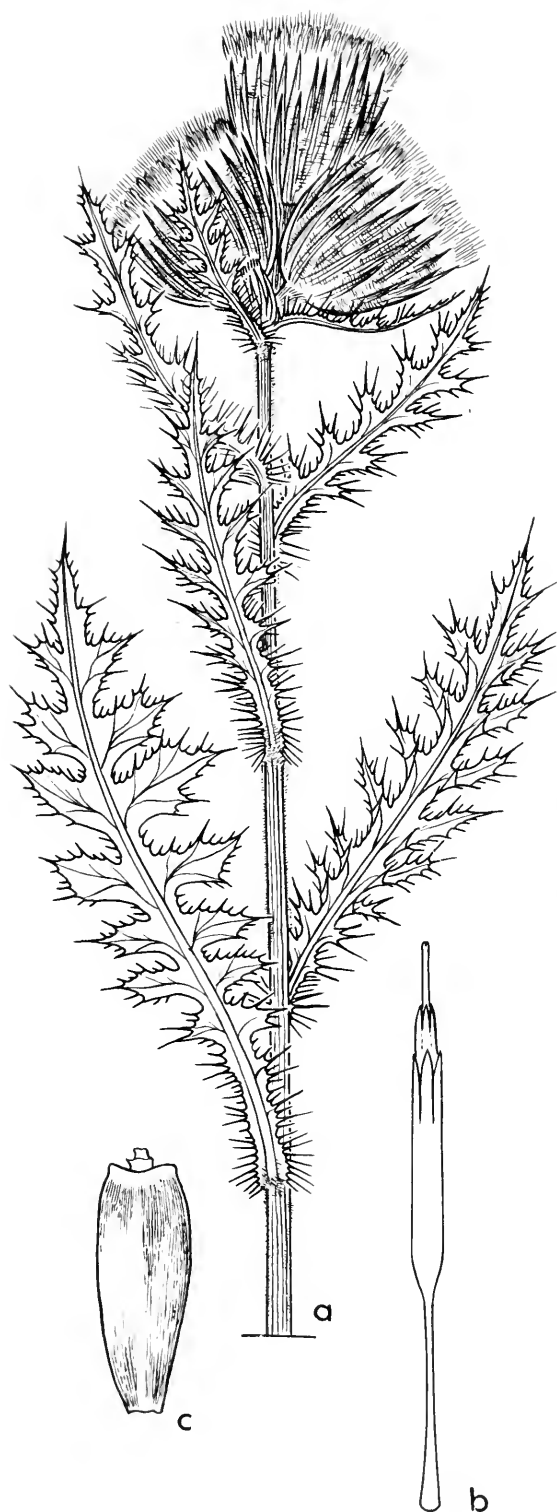
Cirsium macounii (Greene) Rydb., Fl. Rocky Mts. 1009, 1069. 1917.

Common name. Edible thistle; cardon

Herb, 3-11 dm, usually 5-7.5 dm high. Stem simple or openly branched above; fleshy, ribbed, glabrate or lightly arachnoid. Basal leaves to 40 cm long, oblanceolate, with narrow, tapering base; cauline leaves usually about 15 cm long and one-third as wide, narrowly elliptic or oblong in outline; leaves pinnately lobed, shallowly lobed, or lobed to three-quarters the width of the blade, the lobes triangular-rectangular, sometimes twice-lobed, lobes often asymmetrical, bases of cauline leaves rounded and clasping the stem; leaf margins bearing slender, yellow 2-5 mm spines. Leaves green or dark green, glabrous or lightly pubescent on both surfaces; veins prominent below, arachnoid. Heads usually in close clusters of 2-5, subtended by several reduced leaves, or heads sometimes single and terminal on lateral branches; heads 2.5-3.5 cm high, 2-4 cm broad. Involucral phyllaries loosely spreading, involucre gray-arachnoid, outer phyllaries densely arachnoid, phyllaries 1.5-2 mm broad at base, 10-15 mm long, linear-lanceolate, eglandular, purplish, tapering to a 1-2 mm spine. Middle and inner phyllaries longer and less spiny; the innermost phyllaries unarmed, the tips flat and pointed. Corollas rose purple, 18-22 mm long; tube 7.5-10.5 mm, throat 5-8.5 mm, with an abrupt transition in width between tube and throat, lobes 4.5-7 mm long; pappus 15-19 mm long, 3-4 mm shorter than the corolla, and consisting of 30-40 buff setae. Anthers 6.5-9 mm long; pollen diam 48-58 μ m; style extruded at least 4 mm beyond the corolla at flowering, the stigmatic joint 3-4 mm below the tip. Achenes 5-6.5 \times 1.5-1.8 mm, purplish black, solid or sometimes with an irregular lighter zone (0.5 mm broad) at the apical end.

Chromosome number. $2n = 34$ (Moore and Frankton 1962b).

Native distribution. British Columbia, Washington, and Oregon.



Cirsium. a-d, *C. edule*. a, habit, $\times \frac{2}{3}$; b, floret, $\times 2\frac{2}{3}$; c, achene, $\times 5$; d, distribution. e-h, *C. brevistylum*. e, leaf, $\times \frac{2}{3}$; f, floret, $\times 2\frac{2}{3}$; g, achene, $\times 5$; h, distribution.

Canadian distribution. British Columbia. *Cirsium edule* extends farther north (to approximately latitude 56°N) and is more westerly in distribution, not being known east of the Okanagan Valley, than the related species, *C. brevistylum*. *Cirsium edule* is found at rather high altitudes (300-2,100 m) in the mountains of Vancouver Island and in the Coast Range of southern British Columbia. It is found farther inland in the northern part of the province. It extends in the Cascade and Coast ranges into the United States. It occurs in moist habitats, flowering from late June to early September.

9. *C. brevistylum* Cronq., Leaflet. West. Bot. 7:26. 1953.

Common name. Indian thistle

Herb, to 3.3 m, more usually 6-9 dm high, from a taproot. Stem unbranched or loosely branched in the upper third, thick, ribbed, brown with dense gray pubescence (long multicellular hairs). Basal leaves to 30 cm in length, oblanceolate, the base narrow and tapering; cauline leaves mostly 10-15 cm long, 2-4 cm wide, narrowly elliptic or oblong, the base clasping the stem, leaves usually lobed to one-third or one-half the width of the blade but sometimes almost entire, the lobes triangular and more regular in form than in the related species *C. edule*, green or light green, the margins bearing slender, yellow, 2-4 mm spines. Leaves generally less variable, less deeply lobed and more symmetrical in form than those of *C. edule*. Heads usually in close clusters of 3-6, closely subtended by a few reduced spiny leaves, sometimes single on lateral branches; heads uniform in size, 3 cm high, 2.5 cm broad. Involucre of loose, rather divergent phyllaries, densely arachnoid, outer phyllaries green, eglandular, densely arachnoid, 1.5-2 mm broad at the base, 10-15 mm long, linear-lanceolate and tapering evenly to a slender 2-3 mm spine; innermost phyllaries to 20 mm, unarmed, the tips pointed, stiff, sometimes erose, twisted. Corollas rose purple, 20-25 mm long; tube 13-17 mm long and 0.3 mm broad, tapering uniformly to the throat, throat 4.5-5 mm long and 0.5 mm broad, lobes 3-4 mm; pappus 18-22 mm long, usually 3-4 mm shorter than the corolla, and of 50-60 white setae. Anthers 3.5-4.5 mm long, pollen diam 48-51 μ m; styles extruded no more than 1.5 mm beyond the corolla at flowering, the stigmatic joint about 4 mm below the tip. Achenes 4-4.5 \times 1 mm, purplish brown and with a very narrow light-colored marginal rim.

Chromosome number. $2n = 34$ (Moore and Frankton 1962b).

Native distribution. British Columbia, Idaho, Montana, and south along the Pacific coast to southern California.

Canadian distribution. British Columbia. This species is found in the coast region of Vancouver Island, at lower altitudes (600 m or less) than the related species, *C. edule*. *Cirsium brevistylum* is known also from the Queen Charlotte

Islands and around the mouth of the Fraser River on the mainland and, farther inland, in the Monashee and Selkirk mountains of southern British Columbia. It is found in moist habitats, such as meadows and forest clearings, and occasionally by roadsides; it flowers from late June through August.

10. *C. scariosum* Nutt., Trans. Phil. Soc. 7:420. 1841.

Carduus scariosus (Nutt.) Heller, Cat. N. Am. Pl. 7. 1898.

Carduus kelseyi Rydb., Mem. N.Y. Bot. Gard. 1:449. 1900.

Cirsium kelseyi (Rydb.) Petrak, Beih. Bot. Centr. 34:548. 1917

Carduus butleri Rydb., Bull. Torr. Bot. Cl. 37:542. 1910.

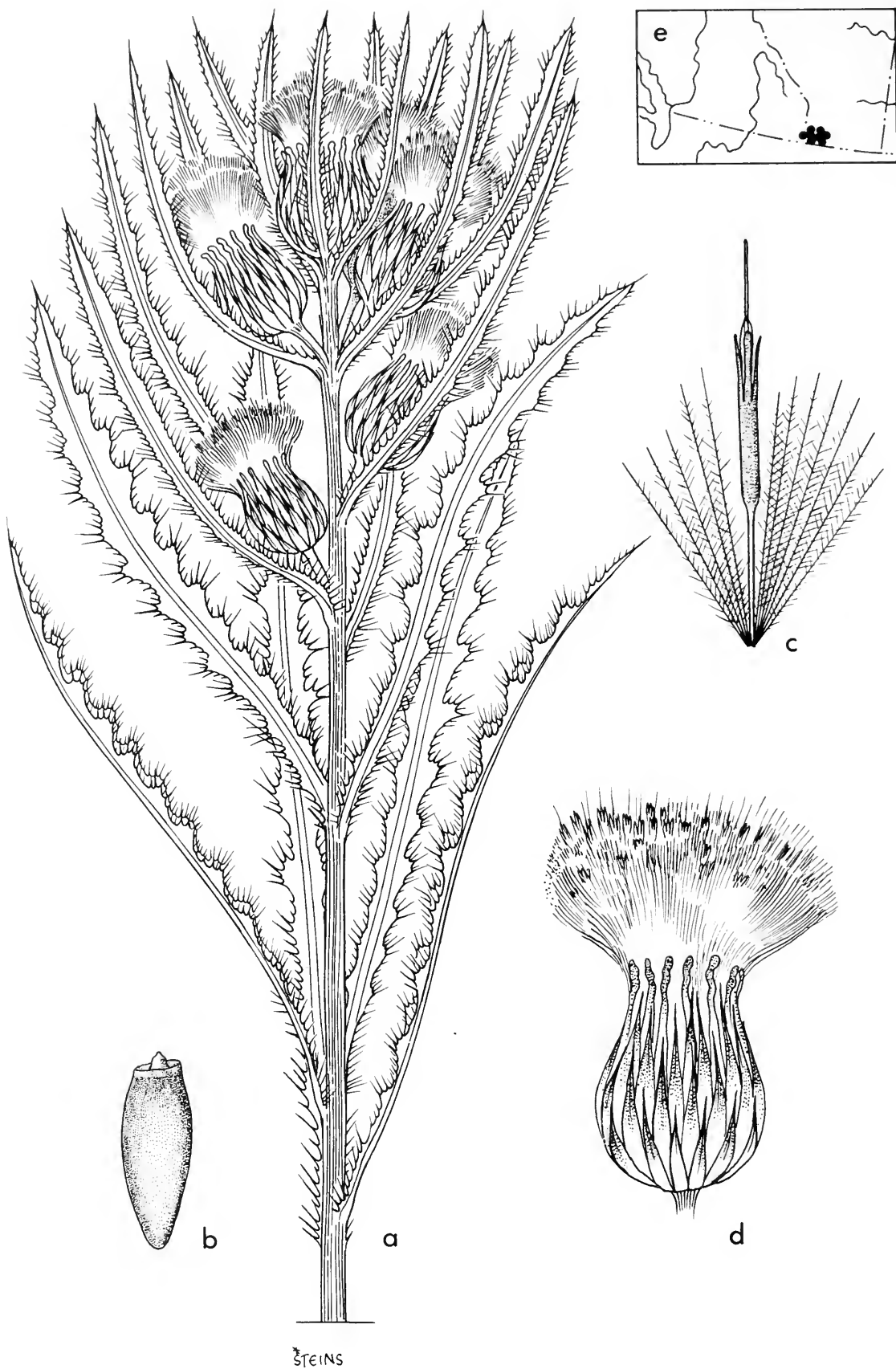
Cirsium butleri (Rydb.) Petrak, Beih. Bot. Centr. 35:539. 1917.

Carduus magnificus A. Nels., Bot. Gaz. 53:228. 1912.

Cirsium magnificum (A. Nels.) Petrak, Beih. Bot. Centr. 35:551. 1917.

Cirsium minganense Vict., Mem. Soc. Roy. Can., Ser. 3. 19:81. 1925.

Biennial herb 2-10 dm high, with a deep taproot. Stem thick, fleshy, ribbed, lightly pubescent (broad multicellular hairs and narrow hairs of one long apical cell and a few small basal cells). Stem unbranched or with a few short upper branches. Flower heads borne singly or in small groups of 2-5 at apex of stem, or sessile along the upper portion of the stem. Rosette leaves of young plants obovate-elliptic, entire or subentire, petiolate; green above, tomentose below. Lower cauline leaves to 25 × 5 cm, narrowly obovate, tapering at the base, petiolate; upper cauline leaves narrowly elliptic or almost linear, sometimes broadest at the base and the base almost clasping, but never decurrent. Leaves of mature plants of the species highly variable in segmentation; pinnately lobed to half the width of the blade or merely shallowly lobed; lobes lanceolate or deltoid, with fine yellow marginal spines to 10 mm long. Upper cauline leaves always smaller and less deeply lobed than the lower ones, often narrow lanceolate, subentire and with numerous fringe-like fine marginal spines. Leaves glabrate above, white woolly below, with fine narrow hairs. Flower heads 5-15 per stem, in either a large terminal aggregation or a smaller terminal group and also in axils of leaves along the upper half of the stem. Terminal clusters of heads loosely enclosed and overtopped by some upper cauline leaves, but less completely enclosed than in *C. foliosum*. Heads 3-4.5 cm high, involucre approximately two-thirds the height of the head and consisting of 5-7 rows of phyllaries, sometimes subequal in length, sometimes the outermost phyllaries about one-third the length of the inner and the phyllaries irregularly and progressively longer from outer to inner. Outer phyllaries 2.5-5 mm broad at base, ovate-lanceolate, the apical portion narrow, acuminate, with a thin 2-4 mm spine, eglandular but often with a dark midline. Innermost row of phyllaries unarmed, the tips membranous, either tapering to a point or dilated, chartaceous and erose to widely varying degrees. Involucral pubescence usually light, consisting



Cirsium scariosum. **a**, habit, $\times \frac{1}{2}$; **b**, achene, $\times 4$; **c**, floret with pappus, $\times 1\frac{1}{2}$; **d**, head, $\times 1$; **e**, distribution.

mainly of fine gray hairs on phyllary margins. Corollas white to pink, perhaps even reddish purple, 18-30 mm long; tube 9-13 mm long, lobes 4-6 mm, anthers 6-10 mm; pappus 4-5 mm shorter than the corolla, of 40-60 setae. Stigma 3.5-5 mm. Pollen diam 50-55 μ m. Achenes 5.5-6.5 \times 2-2.5 mm, light or dark brown, with a narrow apical yellow band.

Chromosome number. $2n = 34$ (Moore and Frankton 1967).

Native distribution. Northwestern United States and adjacent Canada.

Canadian distribution. Southwestern Alberta, southeastern British Columbia, and the Mingan Islands of Quebec. It flowers from late July through August.

Cirsium scariosum is often confused with *C. foliosum* and *C. hookerianum*. There is a superficial resemblance among the three species and it may be that they are related through ancient hybridization. *Cirsium minganense*, a rare endemic of the Mingan Islands of Quebec, seems to be morphologically identical with *C. scariosum*. How the western species reached these islands in the Gulf of St. Lawrence is a disputed question. The eastern plants may be relicts of an ancient migration or may be a chance introduction by man, about 1920 (Moore and Frankton 1967). Small populations survived on three of the islands in 1969 (Morisset 1971).

11. *C. muticum* Michx., Fl. Bor. Am. II, 89. 1803.

Carduus muticus (Michx.) Pers., Syn. II, 386. 1807.

Cnicus muticus (Michx.) Muhl., Cat. Pl. Am. Sept. II, 506. 1814.

Cnicus glutinosus Bigelow, Fl. Boston, 2nd ed. 291. 1824.

Cirsium bigelowii DC., Prodromus VI, 652. 1837.

Common name. Swamp thistle

Biennial herb to 18 dm high. Stem soft, hollow, ribbed, green or sparsely pilose, loosely branched, each branch bearing 1-3 flower heads, sometimes in a sessile cluster or sometimes each head on a short lateral branch. Lower cauline leaves to 55 cm long, 20 cm broad; upper leaves progressively smaller; leaves sessile, ovate in outline, pinnately lobed almost to the midrib; lobes narrow, lanceolate-oblong, remote, often asymmetrical and forked; fine spines to 3 mm long on leaf margins and angles; leaves green above, only lightly pilose, lighter in color and more pubescent below, but not densely tomentose; hairs on the upper surface broad and multicellular, hairs on lower surface mainly narrow and composed of a single long apical cell and 1-few short basal cells. Heads 2.5-3.5 cm high; involucre 2.0-2.5 cm high, bell-shaped, base rounded, composed of about eight rows of progressively longer phyllaries. Outer phyllaries ovate, 3-4 mm broad at the base, apex bearing a very short prickle (0.5 mm or less), margin at the apex sometimes minutely

toothed, phyllaries strongly glandular, margin and lower portion of phyllaries arachnoid to densely tomentose; innermost phyllaries longer, linear-lanceolate, the apex flat, thin, and tapering, occasionally slightly dilated and twisted or curled. Corollas lavender to deep lavender, 16-30 mm long; tube 7-14 mm, throat 5-10 mm, lobes 4-5 mm. Pappus 12-20 mm long, consisting of 30-35 grayish white setae. Anthers 7-9 mm long, apex acute, filaments brown and covered with sparse short hairs to 0.1 mm in length. Pollen grains tricolporate, 48-58 μ m in diam. Achenes 4-6 mm long, 1.5-2 mm wide, dark brown with a yellow apical band 0.3-0.5 mm wide; surface of achenes not mucilaginous when wet.

Chromosome number. $2n = 20$ (Ownbey 1951; Ownbey and Hsi 1963). $2n = 20, 22, 30, 31$ (Frankton and Moore 1963). The normal somatic number of this species is 20 but a few accessory chromosomes sometimes occur. An unusual triploid plant ($2n = 30$) was found in the southeastern United States (Frankton and Moore 1963).

Native distribution. Eastern North America.

Canadian distribution. Swamp thistle is common in moist habitats, such as riverbanks, meadows, and thickets, in Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, and Saskatchewan, to approximately latitude 53°N. The plants flower from mid-July through September.

The variant, forma *monticola* (Fern.) Boivin, has been collected on mountains in Newfoundland and in the Gaspé Peninsula of Quebec. These plants are shorter (to 4.5 dm) and have a close cluster of sessile flower heads; the heads are smaller (to 2.5 cm high) and the involucre less pubescent. The leaves are smaller and darker green and more symmetrically lobed than in the typical. It may be that the more rigorous alpine environment alone is responsible for the characters and that the form is not a distinct genotype.

A white-flowered variant has been found in Newfoundland, Quebec, and Saskatchewan and may be expected to occur at random. This variant is best recognized as forma *lactiflorum* Fern. (var. *albiflorum* Farw.).

The form *subpinnatifidum* (Britt.) Fern. has shallowly undulate-lobed leaves, with only a few short lobes. This form, reported in the northeastern United States, has not yet been noted in Canada.

12. *C. discolor* (Muhl. ex Willd.) Spreng., Syst. veg. III, 375. 1826.

Cnicus discolor Muhl. ex Willd., Sp. Pl. III, 3, 1670. 1800.

Carduus discolor (Muhl. ex Willd.) Nutt., Gen. N. Am. Pl. II, 130. 1818.

— non Hooker, Fl. Bor. Am. I, 303. 1833, pro parte.

Cnicus altissimus var. *discolor* (Muhl. ex Willd.) A. Gray, Proc. Am. Acad. Arts & Sci. 19:57. 1883.

Biennial, perhaps perennial, 1-3 m high. Stems woody, hollow, ribbed, green or greenish brown, lightly pilose with mainly multicellular hairs; stems freely branched, each branch bearing a single flower head. Lower cauline leaves to 50×25 cm, elliptic in outline, deeply lobed to three-quarters the width of the leaf, lobes few, remote, narrow-oblong, often forked, lobing often asymmetrical, leaf margins and apices bearing fine 1-3 mm spines. Upper cauline leaves similar, progressively smaller. Leaves green above, lightly pilose (short broad multicellular hairs and narrow hairs composed of a single long apical cell and 1-few short basal cells); densely woolly below (narrow few-celled hairs). Heads 3.5-4 cm high, involucres 2.5-3 cm high, campanulate, base obtuse, rounded, consisting of about 8 rows of regular, progressively longer phyllaries, the outer 5 rows of phyllaries tipped by slender, spreading, 5-6 mm spines, the inner phyllaries unarmed. Outer phyllaries broadly lanceolate or ovate, to 3 mm broad, strongly glandular, the surface glabrous but often arachnoid on the margins. Innermost phyllaries membranous, tapering to a flexible tip, the tip not dilated. Corollas pinkish lavender, 25-32 mm long; tube 12-16 mm, throat 5-7 mm, lobes 6-9 mm. Pappus 18-25 mm long, of 50-60 white setae. Anthers 8-10 mm, tips narrow, acute, filaments brown, bearing abundant hairs about 0.2 mm long. Pollen tricolporate, diam 51-56 μ m. Achenes 4-5 mm long, 1.2-1.7 mm broad, light brown with darker striae and with a yellow apical collar 0.5-0.75 mm broad; surface not mucilaginous when wet.

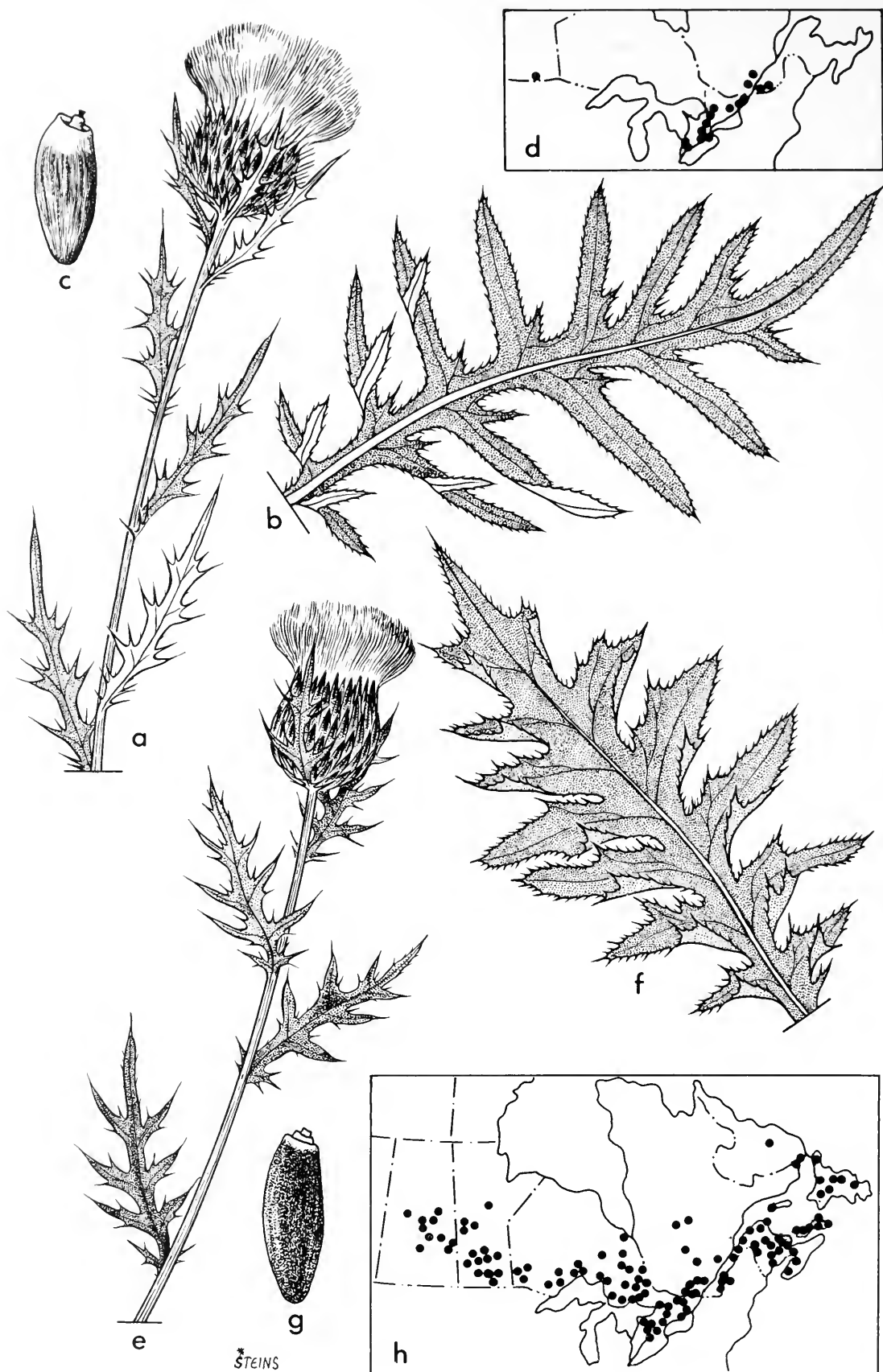
Chromosome number. $2n = 20$ (Ownbey 1951; Ownbey and Hsi 1963). $2n = 20, 21$ (Frankton and Moore 1963). In addition to the normal somatic complement of 20 chromosomes, one accessory chromosome has been found. Several accessory chromosomes may be expected to occur in different populations.

Native distribution. Eastern North America.

Canadian distribution. This species is found in southern Ontario and adjacent southwestern Quebec. A collection from Manitoba, just north of the International Boundary, is known. The range in Canada is the northern extreme of the main range in the United States, where the species is found in the northeastern states, south to Georgia and west to North Dakota. *Cirsium discolor* is closely related to *C. altissimum*. In our opinion, the latter species does not occur in Canada. We have seen some Canadian collections identified as *C. altissimum*, but we consider these to be *C. discolor*.

Cirsium discolor is found by roadsides, in clearings and openings in woods, and in various moist but not marshy habitats. It flowers from late July until late September.

A white-flowered form, forma *albiflorum* House, has been described.



Cirsium. *a-d*, *C. discolor*. *a*, habit, $\times \frac{1}{2}$; *b*, lower leaf, $\times \frac{1}{2}$; *c*, achene, $\times 4$; *d*, distribution. *e-h*, *C. muticum*. *e*, habit, $\times \frac{1}{2}$; *f*, lower leaf, $\times \frac{1}{2}$; *g*, achene, $\times 4$; *h*, distribution.

13. *C. pitcheri* (Torr. ex Eaton) T. & G., Fl. N. Am. II, 456. 1843.

Cnicus pitcheri Torr. ex Eaton, Eaton Man. 5th ed. 180. 1824.

Carduus pitcheri (Torr. ex Eaton) Steudel, Nomen Bot. 2nd ed. I, 284. 1840.

Carduus pitcheri (Torr. ex Eaton) Porter, Mem. Torr. Bot. Cl. 3:345. 1894.

Common name. Pitcher's thistle

Biennial herb with a long taproot. Plant to 8 dm high. Stem slender and rather woody, ribbed, gray tomentose, short-branched at the summit and bearing 1-5 heads. Cauline leaves to 2 dm long, basal leaves to 3 dm, all leaves deeply pinnately segmented to the midrib into linear or narrowly oblong divisions, tipped by a minute spine. Leaves flexible, green above, gray below, with dense tomentum of long, wavy hairs composed of a long apical cell and several short basal cells. Heads 3.5-5 cm high, involucre 2-3 cm high, composed of about 6 rows of dark-colored phyllaries, progressively longer from outer to inner rows. Outer phyllaries about 3 mm broad, ovate-lanceolate, terminal spine 2-3 mm; strongly glandular, with sparse arachnoid marginal pubescence. Innermost phyllaries unarmed, the tips tapering, twisted. Flowers white or pinkish white. Corollas 20-30 mm long; tube 8.5-15 mm, throat 4.5-10 mm, lobes 3-8 mm; pappus about 1 mm shorter than the corolla, composed of 55-65 tawny setae. Anthers 7.5-8.5 mm long. Pollen tricolporate, polar diam 51-58 μm ; walls thick, 8-9 μm ; spines stout. Achenes 6.5-7.5 mm long, 2.5 mm broad, brown or purplish brown, with a very narrow (0.2 mm) lighter apical rim, surface of achene mucilaginous when wet.

Chromosome number. $2n = 34$ (Ownbey and Hsi 1963; Moore and Frankton 1963).

Native distribution. Sandy shores of lakes Michigan, Huron, and Superior.

Canadian distribution. *Cirsium pitcheri* occurs only in Ontario, on sandy beaches and dunes of the shores of Lake Huron and Georgian Bay.

It is known also from the south (United States) shore of Lake Superior and from many locations around Lake Michigan (Guire and Voss 1963). The species is restricted to these shoreline habitats.

14. *C. flodmanii* (Rydb.) Arthur, Torreya 12:31. 1912.

Carduus flodmanii Rydb., Mem. N.Y. Bot. Gard. 1:451. 1900.

Cirsium flodmanii (Rydb.) Britt., Britton & Brown, Ill. Fl. 2nd ed. III, 551. 1913.

Cirsium nebraskense sensu Lunell, Am. Midl. Nat. 2:301. 1912, non *nebraskense* Britt.

Common name. Flodman's thistle



Cirsium pitcheri. a, habit, $\times \frac{1}{2}$; b, seedling rosette, $\times \frac{1}{2}$; c, achene $\times 4$; d, distribution.

Herb, 3-9 dm high; with a slender taproot and spreading readily by root sprouts; biennial but forming a perennial clone by root sprouts. Stem woody, gray, woolly; simple or branched in the upper half, each branch terminated by a single large flower head. Rosette leaves oblanceolate, pinnately lobed or often only remotely lobed or entire; green above, gray tomentose below. Lower leaves of flowering stems oblanceolate or narrowly elliptic, with a tapering petiole-like base, leaves to approximately 20×6 cm, pinnately lobed to three-quarters the width of the blade, lobes lanceolate, tipped by a strong 3-6 mm spine, green, glabrous or sparingly floccose above, gray tomentose below. Upper cauline leaves progressively smaller, lanceolate, lobes smaller and fewer, the bases often clasping. All leaves entire in the form *oblanceolatum*. Heads 3.5-4 cm high; involucre 2-2.5 cm high, of 6-7 rows of progressively longer phyllaries. Outer phyllaries ovate or ovate-lanceolate, 2.5-3 mm broad, glabrate, with light arachnoid pubescence on the surface and margins, strongly glandular, tipped by a strong, diverging 2-4 mm spine; inner phyllaries longer, spiny; innermost phyllaries unarmed, the tips flat and twisted. Flowers deep purple, rarely white. Corollas 21-36 mm long; tube 11-16 mm, throat 6-12 mm, lobes 5-9 mm; pappus 20-30 mm long, of 50-60 white setae. Anthers 6.5-12 mm long, the filaments clothed with densely matted, long hairs. Pollen tricolporate, diam 40-58 μm , walls thick, with broad stout spines. Achenes $3.5\text{-}5.5 \times 1.5\text{-}2$ mm; brown, with a 0.5 mm broad, whitish yellow apical margin; surface of achenes not mucilaginous when wet.

Chromosome number. $2n = 22$ (Frankton and Moore 1961). $n = 11$, $2n = 22$, 24 (Ownbey and Hsi 1963).

Native distribution. Prairie Provinces of Canada and the adjacent United States, south to Colorado and Utah; rare, in a few widely separated locations in Ontario, Quebec, and the New England states.

Canadian distribution. Widespread in southern Manitoba, Saskatchewan, and Alberta, to approximately latitude 54°N . A collection from the Kootenay District of British Columbia has been seen, but the species is otherwise known only east of the Rockies. This species has been collected at several locations in Ontario and Quebec, far beyond the main range, and similar outlying stations in the northeastern United States, at approximately the same latitude, are known. It has been suggested that these outlying populations are the result of chance distribution by man, but this explanation seems scarcely satisfactory. We have recently advanced the hypothesis that the eastern occurrences are relicts of an earlier range when the species covered the northeastern states and southeastern Canada and that the population has subsequently migrated westward, reaching, but not yet crossing, the Rocky Mountains. Climatic conditions in the east presumably became unsuitable for the species and it has survived there in only a few suitable environments (Moore and Frankton 1969).

In the western provinces, *C. flodmanii* is a common plant of grasslands and roadsides. It tends to occur in moister habitats than those occupied by *C. undulatum*. *Cirsium flodmanii* generally begins to flower in mid-July, a little later than *C. undulatum*.

The white-flowered form, f. *albiflorum* D. Löve, has been collected in the three Prairie Provinces.

The form *oblanceolatum* (Rydb.) D. Löve & J.P. Bernard is an extreme form with entire lanceolate basal and cauline leaves. The spines are weaker and the plant is more slender than the typical form. This form has been reported from Manitoba, but may be expected to occur anywhere throughout the range of the species.

15. *C. undulatum* (Nutt.) Spreng., Syst. veg. III, 374. 1826.

Carduus undulatus Nutt., Gen. N. Am. Pl. II, 130. 1818.

Cnicus undulatus (Nutt.) Gray, Proc. Am. Acad. Arts & Sci. 10:42. 1874.

Cnicus undulatus var. *megacephalus* A. Gray, Proc. Am. Acad. Arts & Sci. 10:42. 1874.

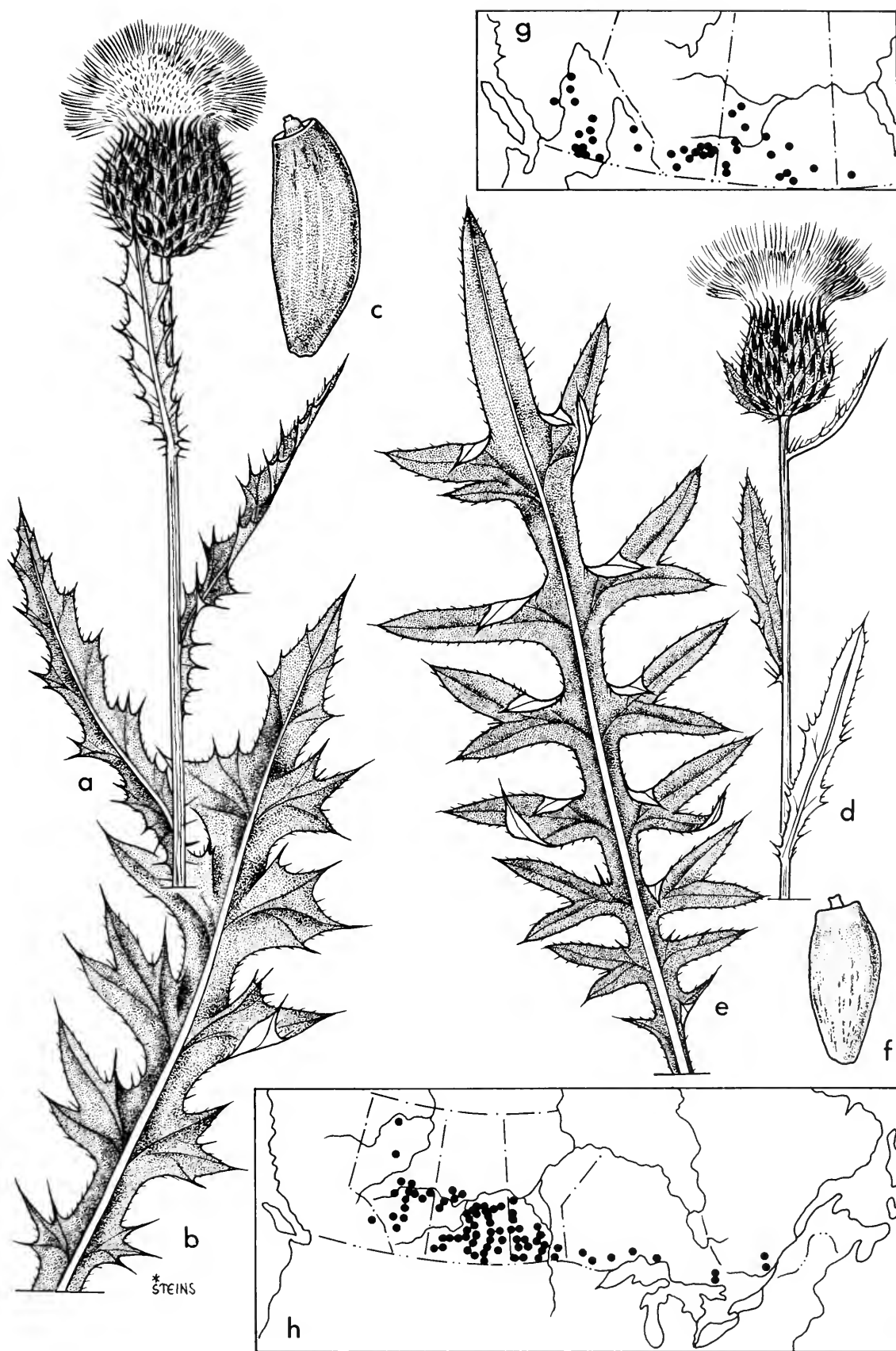
Carduus undulatus var. *megacephalus* (Gray) Greene, Proc. Acad. Phila. 1892:360. 1893.

Cirsium undulatum var. *megacephalum* (Gray) Fern., Rhodora 10:94. 1908.

Common name. Wavy-leaved thistle

Biennial herb with a deep taproot, spreading somewhat by root sprouts to form a perennial clone. Plant to 12 dm high. Stems woody, slender, gray tomentose, simple or branched near the top into a few short branches, each bearing a single large head. Rosette leaves subentire or pinnately lobed, the lobes directed toward the apex of the leaf; both surfaces gray tomentose, the lower surface more heavily so. Lower leaves of flowering stems oblanceolate or linear-elliptic, the base tapering, petiole-like, leaves to 40 cm long, 10 cm broad, pinnately lobed to two-thirds the width of the blade, the lobes often bifid, tipped by a strong, yellow spine, to 5 mm long; upper leaves smaller, lanceolate, less deeply lobed, the base clasping or very shortly decurrent, densely gray tomentose below, thinly tomentose above, with long wavy hairs consisting of a single long apical cell and 1-few short basal cells. Heads 4-6 cm high, involucre 2-3 cm high, consisting of about 6 rows of progressively longer phyllaries. Outer phyllaries ovate or ovate-lanceolate, 2.5-3.5 mm broad, rather woody, glabrate with marginal arachnoid pubescence, strongly glandular, the phyllaries tipped by a strong, yellow, diverging spine, to 5 mm long; innermost phyllaries long, unarmed, the tips tapering, pointed, somewhat twisted. Flowers purple or light purple, rarely white. Corollas 25-40 mm long; tubes 12-21 mm, throats 6-10 mm, lobes 6-8 mm; pappus 20-30 mm long, about three-quarters the length of the corolla, of 50-60 white setae. Anthers 9-13 mm long, the filaments bearing short, sparse hairs. Pollen tricolporate, 52-65 μ m, walls thick, with broad stout spines. Achenes 5-7 \times 2-3 mm; brown, without a lighter apical band or only a very narrow lighter margin (to 0.3 mm); surface of achenes mucilaginous when wet.

Chromosome number. $2n = 26$ (Frankton and Moore 1961; Ownbey and Hsi 1963).



Cirsium. a-d, *C. undulatum*. a, habit, $\times \frac{1}{2}$; b, lower leaf, $\times \frac{1}{2}$; c, achene, $\times 5$; d, distribution. e-h, *C. flodmanii*. e, habit, $\times \frac{1}{2}$; f, lower leaf, $\times \frac{1}{2}$; g, achene, $\times 5$; h, distribution.

Native distribution. Western Canada and the United States, to Mexico.

Canadian distribution. Southern Manitoba, Saskatchewan, Alberta, and British Columbia, north to approximately latitude 53°30'N. It is common in the three Prairie Provinces, but nowhere abundant. It occurs in prairies, grasslands, and roadsides, flowering from early July to September. *Cirsium undulatum* is found in well-drained soils, generally in drier locations than those occupied by the rather similar species *C. flodmanii*. The white-flowered form, f. *album* Farwell, has been collected in Saskatchewan. A variety (var. *franktonis* Boivin) with smaller heads (2-2.5 cm), pink flowers, and smaller seeds (± 6 mm) has been described from British Columbia.

***Cirsium kamtschaticum* Ledeb.**

Although not found in Canada, this species may be mentioned here because it is native to the northern part of our continent.

Cirsium kamtschaticum is found in the Aleutian Islands (Attu, Shemya, and Bering Islands.) Its affinity lies with the Asiatic species of *Cirsium* and it is obviously a migrant from Asia.

The plants may reach a height of 2.1 m, stems are thick and fleshy, ribbed, weakly winged. Leaves are large, obovate in outline and regularly pinnately segmented to two-thirds the width of the blade, lobes lanceolate; leaves thin and glabrous, marginal spines few and fine, to 5 mm long, the leaf bases clasping and decurrent. Heads are borne singly on slender peduncles or on pedicels of the branched peduncle, heads approximately 2 cm high, involucre 1.5 cm; phyllaries lanceolate, about 1 mm broad, loose, subequal in length, lightly arachnoid, thin and flexible, tip scarcely spinous; flowers purple or pink.

HYBRIDS

Many natural hybrids between North American species of *Cirsium* have been described. The following hybrids between species that occur in Canada have been reported.

C. hookerianum* × *C. undulatum

A variable lot of plants (*Calder & Spicer* 33447, DAO) collected at Nicolet Lake, east of Merritt, B.C. (49°50'N, 120°35'W), are believed to be hybrids between the above species (Moore and Frankton 1965). Typical *C. hookerianum* also was collected in this area; *C. undulatum* was not noted by the collectors.

Most of the hybrid plants superficially resembled *C. hookerianum*; some hybrids had pink flowers and these plants differed more from *C. hookerianum* than did the white-flowered plants. It is believed that the pink-flowered plants were first-generation hybrids and that white-flowered plants were later-generation segregates or backcrosses to *C. hookerianum*.

The hybrid nature of the swarm is shown in the following characters by which the hybrids differ from typical *C. hookerianum*; heads larger (3-4 cm high) and borne singly or a few on lateral branches; outer involucreal phyllaries less densely pubescent, with a stronger, dark, glandular midline, phyllary spine divergent, the phyllaries not subequal in length but almost regularly imbricate, the inner phyllaries being twice the length of the outer; florets pink.

These characters suggest that the other parent was a purple-flowered plant, with large heads borne singly on branches with an imbricate, glabrous, strongly glandular involucre. The only species that provides these characters and occurs in the general area is *C. undulatum*.

The amount of apparently normal pollen varied from 1.5% in a pink-flowered plant to almost 100% in the white-flowered specimens. These figures support the belief that the pink-flowered plants are first-generation hybrids. It is of particular interest that this case of natural hybridization involves two species that are considered to be of distant relationship and have different chromosome numbers.

***C. × vancouverense* Moore & Frankton, Can. J. Bot. 40:1190. 1962.**

Hybrid between *C. edule* and *C. brevistylum*

This natural hybrid was collected in 1939 and 1950 on Vancouver Island, B.C., at three locations (Nanaimo, MacMillan Park, Cowichan Lake) within an area of 64 km in regions of moderate altitude (300-600 m) in which both parental species occur.

The parental species are similar in general appearance but can be sharply separated most readily by floral characters. In *C. edule*, the corolla is larger, notably in width, the anthers are longer and the style is extruded, at flowering time, more than twice as far as in *C. brevistylum*. The stylar character, from which Cronquist's species takes its name, is readily observed. These combinations of characters suggest that *C. brevistylum* may be self-compatible, whereas *C. edule* may be an outcrossing species. In addition to floral characters, *C. edule* has larger flower heads and larger, more deeply lobed and spinier leaves.

The hybrid resembles *C. brevistylum* more closely than *C. edule*. The flower of the hybrid is even smaller than that of *C. brevistylum* and the pappus is short and sparse. The anthers are small (3-3.5 mm) and about half the pollen grains are aborted and have unusually thick walls. However, the style is extruded to a distance of 3-4 mm, twice as far as found in *C. brevistylum*, and in this character the hybrid differs distinctly from *C. brevistylum*. Leaves

of the hybrid are slightly larger, darker green, and more glabrous on the upper surface than those of *C. brevistylum*. The size and shape of the leaf lobes also resemble those of *C. edule*.

C. muticum* × *C. discolor

A hybrid population between these species was discovered in Minnesota and carefully described by Ownbey (1951). The hybrids were intermediate between the parents in several characters, notably: length of involucre spines (spines of third row of phyllaries 0.3-2.8 mm, average 1.3 mm); diameter of involucre (average 14.6 mm, whereas average of *C. discolor* was 15.6 mm, of *C. muticum*, 13 mm); pubescence of lower surface of leaf. Only 3% of pollen was normal and the hybrids set few seeds.

These species are usually isolated by ecological factors; *C. muticum* is restricted to much moister locations than those occupied by *C. discolor*. Hybrids have not been noted in Canada but may be formed if changes in local habitats bring the two species together, as occurred in the case of the hybrids studied by Ownbey.

RELATIONSHIPS IN NATIVE SPECIES OF *CIRSIIUM*

Among the native North American species of *Cirsium* a number of natural groups of closely related species are evident. Most of these groups occur only in the United States but several extend into Canada. Five groups are represented in Canada by the following species:

C. muticum – *C. discolor* – *C. flodmanii*

C. undulatum – *C. pitcheri*

C. foliosum – *C. drummondii* – *C. pumilum*

C. scariosum – *C. hookerianum*

C. edule – *C. brevistylum*

The basic chromosome number of the genus is 17 ($n = 17$, $2n = 34$). Within some groups of North American species lower chromosome numbers have evolved, apparently by the translocation of chromosome material to form fewer but longer chromosomes. Within such groups, some species may retain the original number 17 while other species are characterized by one or more reduced numbers. The unity of these species-groups, originally recognized by their morphological similarities, is further supported by this cytological character. Groups within which chromosome number reduction has occurred are represented by the first two groups above. A reduction in number has taken place also between *C. drummondii* and *C. pumilum* but it is not clear whether this is a similar phenomenon — whether the decrease is due to the translocation of material or to the complete loss of two pairs of chromosomes.

Our species entered Canada from the south after the withdrawal of the glaciers. Some Canadian species apparently originated long ago in the United States and, after occupying large areas there, moved into Canada unchanged as the continent was freed of ice. Such are the species of the first two groups listed above.

Some of our species are found mainly in Canada and it appears that these species have evolved more recently in the northern states. Presumably the species originated from southerly stocks, either by hybridization as the general northward migration began, or by gene mutation and selection for characters that proved to be advantageous in the northward movement.

The third group (*C. foliosum* – *C. drummondii* – *C. pumilum*) appears to have developed after glaciation, near the Canadian border, from an ancestral stock now found in the western states. The variable *C. scariosum*, which shows affinities to *C. foliosum* and to *C. hookerianum*, is also possibly a derivative of this "Foliosa" stock, hybridized with another southerly stock that resembles our *C. hookerianum*.

Cirsium edule and *C. brevistylum* are Pacific coast species without close relations in our flora. Probably *C. brevistylum* evolved from *C. edule*. The small florets of *C. brevistylum* appear to be adapted to self-pollination and the development of self-fertility may have guided the formation of this species.

CARDUUS Plumeless thistles; chardons épineux

***Carduus* L., Sp. Pl. 821. 1753.**

Annual or biennial, usually tall, branched herbs. Leaves entire or deeply pinnately divided, spiny-margined. Involucre of several series of phyllaries; phyllaries eglandular, lanceolate to linear, ending in a spine or a point. Heads medium to large; all florets similar, tubular, perfect, corolla 5-parted, anthers 5, filaments glabrous or hairy, caudal appendages bifid. Receptacles densely setose. Pappus of individual florets consisting of numerous silky, nonplumose setae. Achenes with a basal attachment.

A recent monograph (Kazmi 1963-64) of this genus recognizes 90 species, in addition to hybrids, with a native distribution extending over Europe, central Asia, and east Africa. Several species have become naturalized in the New World and have become serious weeds. Three introduced species have been found in Canada and two of these have become widespread and weedy. The distribution of *Carduus* in Canada was described previously by Mulligan and Frankton (1954).

Uses. Apparently no medicinal use has been made of these plants. The young stalks of *C. eriophorus* have been used as a salad green or baked in a pie and the pappus of *C. nutans* was once used to make paper (Grieve 1931).

KEY TO THE SPECIES

Heads subglobose or ovoid, small (1-3 cm in diam), erect, peduncles spiny-winged up to, or almost to, the heads; phyllaries narrow (1-1.5 mm) and without a submedian constriction.

Heads 1.8-2.3 cm high, involucre 1.4-2.0 cm high; leaves glabrate below, except for long curled septate hairs on the veins; flowers purple, white, or cream1. ***C. acanthoides***

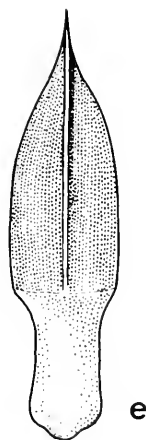
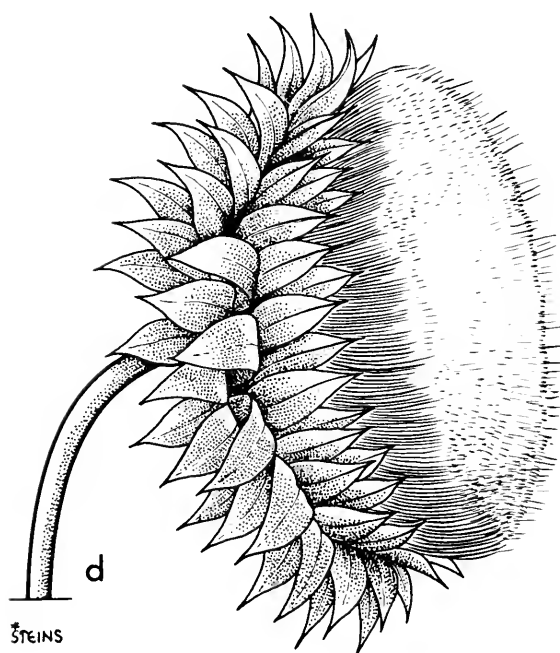
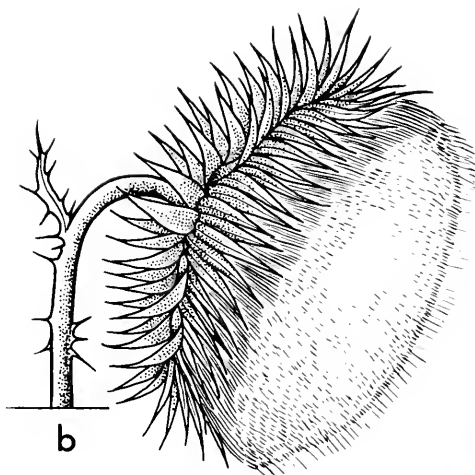
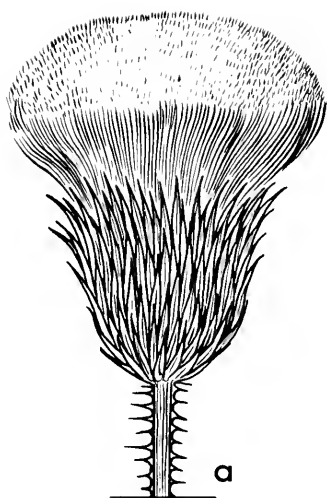
Heads 1.5-1.8 cm high, involucre 1.2-1.7 cm high; leaves sparsely or densely tomentose below (matted, fine, nonseptate hairs) and often with septate hairs on the midrib; flowers purple.2. ***C. crispus***

Heads globose or ovoid, large (2-7 cm in diam), nodding, peduncles naked for some distance below the head; phyllaries broader (2-8 mm) and with a shallow submedian constriction.3. ***C. nutans***

1. *C. acanthoides* L., Sp. Pl. 821. 1753.

An extensive synonymy is given by Kazmi (1963-64), but the names are not often met in the literature.

Annual or biennial herb to 1.5 m high, freely branched above. Stems furrowed, yellowish green, glabrate, with scattered multicellular hairs, bearing



Carduus. *a*, *C. acanthoides*, head, $\times 1$. *b-c*, *C. nutans* ssp. *nutans*. *b*, head, $\times 1$; *c*, outer phyllary, $\times 1\frac{1}{2}$.

spiny wings to 1.5 cm wide which extend to the flower heads; the ultimate branches, when fully developed, bearing a single erect head but on younger plants, the heads in a small cluster. Leaves narrowly elliptic or oblong in outline, deeply and often irregularly pinnatifid, the segments 1-3 pointed, marginal spines slender, to 4 mm; leaf bases decurrent; leaves yellow green, glabrous above, glabrate below, mainly with scattered multicellular hairs along the prominent veins. Heads 1.8-2.5 cm high, width about two-thirds the height. Involucre 1.4-2 cm high; the outer phyllaries spreading-reflexed, lanceolate-linear, lightly or densely arachnoid, 1-1.5 mm broad at the base, apical portion about 0.8 mm broad, tapering gradually or sometimes the tip obtuse, rounded and pigmented, terminal spine 1.5-2 mm. Phyllaries usually not regularly and progressively longer but falling in 2-3 length classes; outer armed phyllaries 7-10 mm long, inner phyllaries longer, to 20 mm, unarmed, the tips flat and pointed or sometimes slightly dilated, twisted. Corollas usually purplish, occasionally white or cream; 15-19 mm long; tube 7-9 mm ($0.46-0.47 \times$ corolla), lobes 6-7 mm. Anthers 5-7 mm long, tips lanceolate, 1 mm, filaments woolly. Stigma bifid, 2-2.5 mm. Pollen diam 47-50 μ m. Achenes $2.5-3 \times 1.3$ mm; straw-colored or light brown and with 15-20 darker, thin longitudinal lines and a lighter apical collar.

Chromosome number. $n = 11$ (Poddubnaja 1927; Moore and Frankton 1962a). $2n = 22$ (Löve and Löve 1944; Gorecka 1956; Moore and Mulligan 1956; Moore and Frankton 1962a). $2n = 16$ (Podlech 1964, as *C. velebiticus* Borb.).

The number $n = 11$, $2n = 22$ is well established for this species. The count of $2n = 16$ reported under a synonym is probably a misidentification of the similar species *C. crispus*.

Native distribution. Europe and Asia.

Canadian distribution. This species is known to be established in Nova Scotia, Quebec, Ontario, and British Columbia, but is common only in certain areas of Ontario.

It has been reported from Yarmouth, Sydney, Pictou, and Pugwash in Nova Scotia, but examination of available specimens indicates that *C. acanthoides* occurs only at Yarmouth and that specimens from the other localities are the similar species *C. crispus*.

Since 1952, *C. acanthoides* has been collected in Huntingdon and Missisquoi counties of Quebec: the westernmost portion of the province, south of the St. Lawrence River.

It has been longer established in Ontario. Rousseau and Raymond (1945) reported that it was collected in 1907 in Peel Co., Ont., and we have seen a collection from the Ottawa area made in 1909. In the past 20 years, *C. acanthoides* has been found in the counties of Carleton, Lanark, Russell, Hastings, and Glengarry, in eastern Ontario. In southwestern Ontario, it is

most abundant in Grey and Bruce counties. It flowers from early June to late September.

Two color forms, f. *albiflora* (L.) Gross — flowers white, and f. *ochranthus* Wallr. — flowers cream, are known. The form *albiflora* is common in Grey Co., Ont.; the form *ochranthus* has been found in Bruce Co., Ont.

2. *C. crispus* L., Sp. Pl. 821. 1753.

An extensive synonymy is given by Kazmi (1963-64). No commonly used names are included.

Common names. Curled thistle, welted thistle; chardon crépu

Tall, annual or biennial herb, branched. Stems furrowed, dark, lightly pubescent (hairs multicellular), with spiny wings to 1.5 cm wide extending usually almost to the flower head; heads usually clustered. Heads 1.5-1.8 cm high. Involucre 1.2-1.7 cm high; outer phyllaries spreading or merely ascending, lanceolate-linear, lightly or densely arachnoid, 1 mm broad, tapering to 1-1.5 mm terminal spine; phyllaries usually, but not always, regularly and progressively longer from outer to inner; inner phyllaries unarmed, tips pointed, flat. Corollas (12-)13-14 (-15) mm; tube 5-6 mm, lobes 4.5-6 mm. Anthers 5-6 mm, filaments woolly; pollen diam 44-50 μ m. Achenes 2.5-3.8 \times 1.3-1.7 mm, light brown or grayish brown with about 20 thin longitudinal brown stripes. Stigma bifid, 2 mm. Leaves varying from subentire to deeply pinnatifid; basal leaves oblanceolate, the base tapering, petiolate; upper leaves narrowly elliptic or lanceolate in outline, subentire to deeply pinnatifid, base narrow and decurrent, thin, marginal spines fine, 1-2 mm, the more deeply segmented leaves bearing more and stronger spines; upper surface green, glabrous or lightly arachnoid, lower surface lighter in color, tomentose, with matted fine nonseptate hairs and often with broader septate hairs on the midrib. Kazmi distinguished the two subspecies in the following manner: ssp. *crispus* — stems few-branched; leaves entire to pinnatifid, spines few, short and weak; phyllaries glabrous to lightly arachnoid; ssp. *occidentalis* — stems often branched; leaves sinuate-dentate or pinnately parted (more deeply parted than in ssp. *crispus*), spines many, long; phyllaries lightly to densely arachnoid, only rarely glabrous.

Chromosome number. $n = 8$ (Poddubnaja 1927). $2n = 16$ (Löve and Löve 1944; Poddubnaja-Arnoldi 1931; Gorecka 1956; Arano 1963). $2n = 21$ (Arano 1957). The number $n = 8$, $2n = 16$ is well established for this species. It may be that the odd somatic number 21 was counted in a hybrid between this species and *C. nutans*.

Native distribution. Europe and Asia. Kazmi recognized two subspecies: ssp. *occidentalis* — Southern Scandinavia, British Isles, Lowlands, France; ssp. *crispus* — Northern Scandinavia and the remainder of the species range.

Canadian distribution. This species is not common in Canada; it has been found at only a few localities in Nova Scotia, New Brunswick, Ontario, and British Columbia since the early 1880's. It was first collected at St. John, N.B., in 1881. It has since been found in Nova Scotia (Pictou, Pugwash, Sydney), in Ontario (Peel Co.) and, recently, in British Columbia (Dawson Creek).

Because *C. acanthoides* and *C. crispus* have been confused in identifications, it may be well to emphasize the distinguishing characters.

Plants of *C. crispus* are less branched and consequently the heads are regularly borne in clusters, rather than singly, as in the more branched *C. acanthoides*. The heads of *C. crispus* are smaller and the phyllaries are more or less spreading-reflexed. The peduncles of *C. crispus* are often naked for several millimetres below the head, whereas those of *C. acanthoides* are winged to the head. The leaves of *C. crispus* are generally less divided, sometimes only shallowly pinnatifid, whereas those of *C. acanthoides* are regularly deeply and sharply segmented and bear strong marginal spines. The leaves of *C. crispus* are woolly below; those of *C. acanthoides* are glabrate, except for septate hairs on the midrib.

3. *C. nutans* L., Sp. Pl. 821. 1753.

Many infraspecific taxa have been described and treatments by different botanists differ in the number and rank of these entities. Kazmi recognized four subspecies under *C. nutans*; only two of these (ssp. *nutans*, ssp. *macrolepis*) have been introduced into Canada. These subspecies are widespread in Europe. A related entity is recognized by Kazmi as a separate species, *C. thoermeri*, but most botanists have treated these plants as a subspecies or variety of *C. nutans*. We consider that it is more appropriate to class this entity as a subspecies of *C. nutans*, for which the valid name is ssp. *leiophyllus*. Therefore we recognize three subspecies of *C. nutans* in Canada.

Erect, biennial herb of several branched stems. Stems furrowed, with spiny wings 1-1.5 cm broad formed by the decurrent leaf bases. Flower heads large, single, and nodding on long slender peduncles, which are naked except for a few bract-like leaves. Cauline leaves lanceolate or oblong-lanceolate, deeply pinnately lobed to four-fifths the width of the blade; lobes lanceolate to ovate with numerous slender marginal spines, leaf bases decurrent. Involucre of about 6 rows of phyllaries; outer phyllaries about one-third the length of the inner. Outer phyllaries ovate-lanceolate to lanceolate with a slight marginal invagination, dividing the phyllaries into an apical and a basal portion often of different widths, the apical portion spreading or reflexed; phyllaries terminated by a strong spine. Inner phyllaries narrow, unarmed or with a weak spine.

Native distribution. *Carduus nutans*, including all the subspecies, has a broad range: Europe and western Siberia, Asia Minor, and North Africa. The ranges of the subspecies are more limited.

KEY TO THE SUBSPECIES

Heads 2-4 cm in diam; outer phyllaries erect, spreading or reflexed, usually only the basal phyllaries reflexed; phyllaries 2-3.5 mm wide, the apical portion longer but not broader than the basal portion, tapering gradually to the apical spine; leaves distinctly pubescent.....ssp. *nutans*

Heads 4-7 cm in diam; outer phyllaries spreading or reflexed but usually most outer phyllaries reflexed; phyllaries 4-9 mm broad, the apical portion broader than the basal portion and as long as or longer than the basal; leaves glabrate or glabrous.

Phyllaries coriaceous, the apical portion rather obtuse or rounded, changing abruptly to the spine.....ssp. *leiophyllus*

Phyllaries subcoriaceous, the apical portion tapering evenly to the spinessp. *macrolepis*

3a. ssp. *nutans*

Common names. Nodding thistle, musk thistle; chardon penché

Herb to 15 dm high. Outer phyllaries flexible, lightly to densely arachnoid, green and usually with some purple marking; 2-3.5 mm wide, the apical portion longer, as wide as or slightly narrower than the basal portion, the apical portion tapering gradually to a strong 2-3 mm spine, which is a prolongation of the prominent midrib. Outer phyllaries mostly erect-spreading, some basal phyllaries often reflexed. Heads 2-4 cm broad. Corollas 18-23 mm long, tube 10-12 mm, lobes 6-9 mm, reddish purple. Anthers 5-7 mm, filaments woolly. Stigma bifid, 2.5-3.5 mm. Pappus about 15 mm long, of 100-140 setae, white. Pollen diam 52-55 μ m. Achenes 3.5 mm long, 1.5 mm wide, glossy, light brown with a narrow (0.2 mm) lighter apical band.

Chromosome number. $n = 8$ (Poddubnaja 1927; Moore and Frankton 1962a). $2n = 16$ (Löve and Löve 1944; Moore and Mulligan 1956; Gorecka 1956).

Native distribution. Europe.

Canadian distribution. Widespread in Ontario; also found in Newfoundland, New Brunswick, and Quebec.

It is a common weed in southern Ontario, particularly in the western counties of Bruce, Grey, Halton, Oxford, Victoria, Waterloo, and Wellington. It also occurs in the eastern counties of Frontenac, Hastings, and Leeds. Our earliest collection was made in 1875 at Bass River, N.B.

The nodding thistle is found in dry, well-drained areas, on sandy or rocky soils, in pastures, along roadsides, and on waste ground.

Some collections from southwestern Ontario classed as ssp. *nutans* seem to contain some genes of ssp. *leiophyllus* The characters of the latter appear

in: (1) foliage tougher in texture and less pubescent than in typical *nutans*; (2) outer phyllaries to 6 mm in width and the apical portion slightly broader than the basal, many of the phyllaries reflexed; (3) heads 3.5-4 cm in diam — on the borderline between the dimensions of the two subspecies. Although rare in Eastern Canada, the subspecies *leiophyllus* has been found in Ontario and Quebec and it may be that hybridization between the two subspecies has taken place.

3b. ssp. *leiophyllus* (Petrovic) Stoj. & Stef., Fl. Bulg. 3rd. ed. 1183. 1948.

Carduus thoermeri Weinm., Bull. Soc. Natl. Mosc. 7:69. 1837.

Carduus nutans L. var. *leiophyllus* sensu Mulligan & Frankton, Can. Field Nat. 68:35. 1954.

Carduus nutans L. var. *vestitus* (Hal.) B. Boivin, Nat. Can. 94:654. 1967.

Kazmi (1963-64) takes up the name *Carduus thoermeri* for this taxon.

Additional synonyms are listed by Kazmi (pp. 329-330).

Common name. Glabrous nodding thistle

Height to 24 dm. Stems glabrous, flower peduncles glabrate. Leaves subcoriaceous, glabrous on both surfaces. Heads 4-7 cm wide, 3-4 cm high. Outer phyllaries spreading or reflexed, the outer several layers usually distinctly reflexed, usually green, sometimes purplish, glabrous, coriaceous, with submedian invagination; the upper portion broader (5-7 mm) than the basal portion; apical portion ovate-lanceolate, the outline slightly curved and not tapering evenly to the 3-4 mm woody apical spine, midribs prominent; inner phyllaries narrower, thinner, often twisted, tips unarmed, pointed. Corollas reddish purple, 19-29 mm long; tube 8-15 mm (approx half the corolla), lobes (5-)7-9 mm. Anthers 6-8 mm, tips apiculate, filaments villous or woolly. Pollen diam about 55 μ m. Pappus about 15 mm, white. Achenes 4 \times 1.5 mm, glossy, light brown with darker longitudinal stripes and a narrow (0.3 mm) lighter apical rim.

Chromosome number. $2n = 16$ (Moore and Frankton 1962a, as *C. nutans* var. *leiophyllus*).

Native distribution. Eastern Europe, southern Russia to the Caspian Sea, Asia Minor, and North Africa.

Canadian distribution. The glabrous nodding thistle has been found in Quebec, Ontario, Saskatchewan, and British Columbia. It is common and a weed only on the prairies.

It is found on sandy loam or clay soils, in grasslands, roadsides, pastures, margins of cultivated fields, and waste land. It flowers from early July to September.

3c. ssp. *macrolepis* (Peterm.) Kazmi, Mitt. bot. Staatssammlung München 5:326. 1964.

Carduus macrolepis Peterm., Flora 27:492. 1844.

Additional synonyms are listed by Kazmi (p. 326).

Outer phyllaries subcoriaceous, glabrate (lightly arachnoid), green and usually with a purple tinge; basal portion 3-3.5 mm wide and narrower than the longer broader (5 mm) apical portion, which tapers smoothly to a 2-4 mm spine; midrib prominent. Outer phyllaries regularly reflexed. Heads 4-7 cm wide. Corolla reddish purple, 28 mm long, tube 16 mm, lobes 8 mm. Anthers 7 mm, filaments woolly. Pollen diam 55 μ m. Stigma bifid, 3 mm. Pappus about 17 mm long. Achenes 3.5 \times 1.5 mm, light brown with a narrow, lighter apical band.

Native distribution. Europe.

Canadian distribution. Only a few collections of this subspecies have been made: Ontario — Hastings Co. in 1955, Carleton Co. in 1966; Manitoba — at Haywood in 1950. In general appearance, this subspecies is similar to the ssp. *leiophyllus*.

HYBRIDS

C. \times *orthocephalus* Wallr., Linnaea 14:638. 1846.

Hybrid between *Carduus acanthoides* and *C. nutans*.

Extensive populations of this hybrid were found in Grey Co., Ont., about 1950 and population changes were studied over a 10-year period (1952-62) by Moore and Mulligan (1956, 1964).

Carduus acanthoides and *C. nutans* ssp. *nutans* occur in this area and it is thought that the hybrids originated there in the late 1940's.

The parental species differ in six prominent characters (character of *C. nutans* stated first): heads solitary/clustered, heads nodding/erect, peduncles naked/spiny-winged, basal phyllaries reflexed/spreading, tips of outer phyllaries purple-marked/not purple-marked, outer phyllaries ovate and contracted at the base/lanceolate and not contracted at base. These differential character pairs were assigned numerical values and the hybrids were scored on a Hybrid Index scale. The Hybrid Index scores were found to be correlated with the intermediate ($2n = 17-21$) chromosome numbers (Moore and Mulligan 1956, 1964; Mulligan and Moore 1961).

Carduus \times *orthocephalus* f. *mulliganii* Boivin is a white-flowered variant.

SAUSSUREA

Saussurea DC., Ann. Mus. Paris 16:156, 196. 1810.
Nomen conservandum.

Nonspinous perennial herbs. Leaves alternate, entire to pinnatifid. Heads solitary or clustered; flowers perfect, corollas tubular, 5-parted, bluish or purplish. Receptacles plane or convex, naked or bearing chaff, scales, or bristles. Achenes oblong, angled, attachment scar basal. Pappus bristles in 1 or 2 series or lacking.

This genus is usually estimated to contain about 130 species, but Lipschitz (1962) estimates that there are 400. Most species of *Saussurea* are Arctic or montane plants. Most occur in Asia, but some species are found in Europe and North America and one in Australia. Three species are native to northern Canada and one introduced species has been found in Canada. About eight species are native to North America, including northern Canada, Alaska, and the northwestern United States.

KEY TO THE SPECIES

Receptacle naked; outer phyllaries about as long as the innermost—1. *S. nuda* var. *densa*

Receptacle chaffy; phyllaries regularly and progressively longer from the outer to the inner whorls.

Inner phyllaries expanded and erose at the tip.....2. *S. glomerata*

Inner phyllaries not expanded at the tip.

Stem leaves 1 cm broad or less, linear to lanceolate, entire or few-toothed, narrowed at the base.....3. *S. angustifolia*

Stem leaves to 5 cm broad, ovate, with large coarse teeth; lower leaves broad-based and petiolate.....4. *S. americana*

1. ***S. nuda*** Ledeb. var. ***densa*** (Hook.) Hult., Fl. Alaska X, 1827. 1950.

Saussurea alpina β *densa* Hook., Fl. Bor. Am. I, 303. 1833.

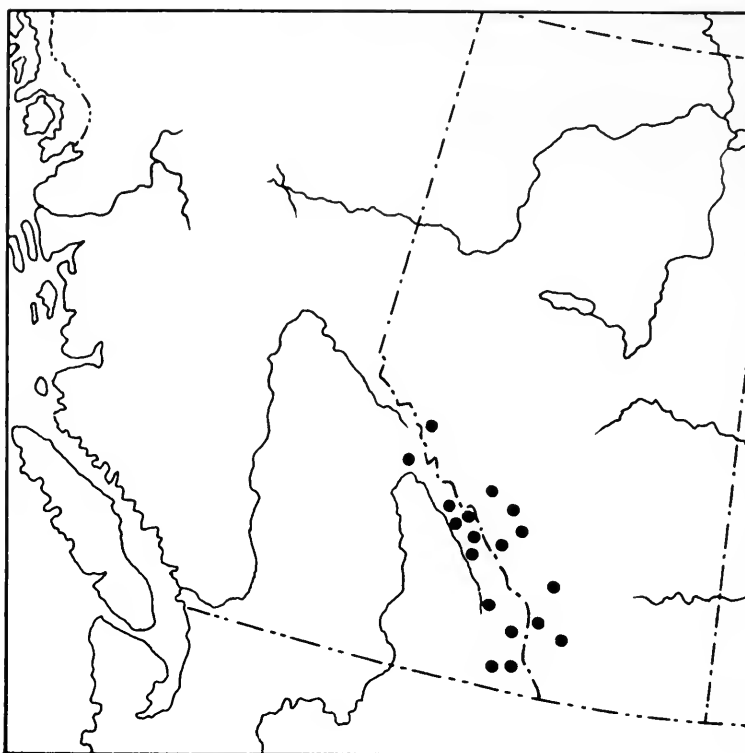
Saussurea alpina var. *ledebouri* A. Gray, Syn. Fl. I, 397. 1884.

Saussurea densa (Hook.) Rydb., Bull. Torrey Bot. Cl. 37:541. 1910.

Low perennial herb, 5-20 cm high, spreading from a dark, woody underground stem. Leaves ascending, narrowly elliptic, numerous and crowded on the short stem, to 10 × 2 cm, glabrate, the margin irregularly repand dentate. Stem fleshy, ribbed, pigmented. Flower heads almost sessile, in a



Saussurea. a, *S. angustifolia*, habit, $\times \frac{2}{3}$. b, *S. nuda* var. *densa*, habit, $\times \frac{2}{3}$.



close cluster (5-12) at the stem apex, usually overtopped by the upper leaves. Heads 2-2.5 cm high; involucre about 12×5 mm and consisting of about 3 rows of phyllaries. Phyllaries green, membranaceous, lanceolate to ovate-lanceolate, lightly sericeous; the outer phyllaries almost as long as the inner. Corollas purple, 12-13 mm long; tube 6-7 mm, narrow; lobes 4 mm long. Anthers 5-6 mm, sterile tip about 0.8 mm, tail short. Pollen diam approximately $50 \mu\text{m}$. Stigma bifid, about 2 mm long. Pappus 1 cm, white, shortly plumose; receptacle naked. Achenes approximately 7×1.5 mm, longitudinally ridged, straw-colored. The variety *densa* differs from the typical variety in its shorter habit, more compact cluster of flower heads, and more denticulate leaves.

Chromosome number. $2n = 26$ (Moore and Frankton 1962a, as *S. densa*; Packer 1964, as *S. densa*). The same number is reported for *S. nuda* by Sokolovskaya (1966).

Native distribution. Rocky Mountains of Canada. The typical variety occurs in northeastern Alaska, the islands of the Bering Sea and Strait, and the Aleutian Islands.

Canadian distribution. Rocky Mountains of British Columbia and Alberta. The plant has been collected at elevations of 2,000 to 2,500 m, on limestone slopes or on shale and in patches of grass or sedge. It is a common but scattered species and flowers from mid-July through August.

2. *S. glomerata* Poir., Encycl. meth. Suppl. V, 71. 1827.

Lipschitz (1962) places *S. glomerata* Poir. in synonymy of *S. amara* (L.) DC. and gives an extensive synonymy. However, he recognizes a slight difference in plants from Dahuria and admits that these plants might be separated as *S. glomerata*. Our specimens match the Dahurian population and we are taking up the segregate species for them.

Slender herb to 3 dm high. Stems branched and each branch bearing several (3-5) sessile heads, the heads of all the branches together forming a corymb. Leaves narrowly elliptic (to approx 12×2 cm), or with a few irregular, pinnatifid lobes; apex acute, base tapering; the upper leaves reduced and bract-like. Heads about 2 cm high; involucre 1.5 cm high, 0.5 cm broad, composed of progressively longer phyllaries. Phyllaries membranous, about 1 mm broad, outer phyllaries acute, unarmed, the inner phyllaries longer, with pinkish tips, the tips expanded to about twice the width of the blade and erose. Corollas lilac, about 17 mm long; tube 11 mm, lobes 4 mm. Anthers about 5 mm long. The plants from Dahuria (*S. glomerata*) are distinguished from *S. amara* s. lat. by fewer heads, narrower leaves, and less expansion of the phyllary tip.

Chromosome number. $2n = 26$ (Zhukova 1964).

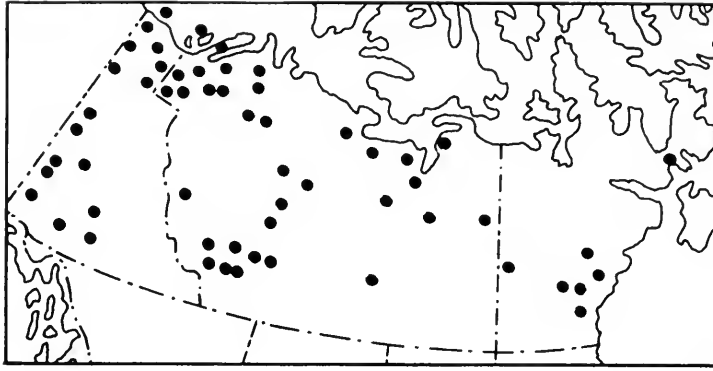
Native distribution. *Saussurea glomerata* is native to the Dahurian steppes, in Eastern Siberia, about 550 km east of Lake Baikal. *Saussurea amara* has a more extensive range: European Russia, central Asia, Siberia.

Canadian distribution. Alberta. Specimens were collected in 1942 at Debolt, east of Grande Prairie, Peace River District. The plants were found in a barnyard and in gardens of the area. The source of introduction is unknown.

3. *S. angustifolia* (Willd.) DC., Ann. Mus. Paris 16:200. 1810.

Slender herb to 4 dm high. Stem simple, terminated by numerous flowering pedicels forming a corymbose cluster; stem thick, fleshy, glabrous, often reddish pigmented. Leaves linear-lanceolate or lanceolate, to 1 cm broad but usually narrower; fleshy, green, the midrib usually pigmented, leaves glabrate above, lightly sericeous below; margins entire to irregularly repand denticulate. Heads borne singly on short pedicels, some almost sessile. Head 15-20 mm high; involucre 12-15 mm high, 5-6 mm broad. Phyllaries ovate or ovate-lanceolate, progressively longer from the outer to the inner; phyllaries membranous, sericeous, dark-pigmented, tips acute, unarmed. Flowers mauve or bluish purple; corollas 13 mm long; tube 7 mm and narrow, lobes 3-4 mm. Pappus approximately 10 mm long, tawny, plumose. Anthers 5 mm long. Pollen diam 45-60 μ m. Achenes approximately 7 mm long, 2 mm broad, dark brown.

Native distribution. Eastern Siberia, islands of the Bering Strait, Alaska, and northwestern Canada.



KEY TO THE VARIETIES

Plants tall (8-40 cm); heads in a corymbose terminal group, at least some of the pedicels 2 cm or longer; cauline leaves narrow, margins entire, upper leaves usually smaller than the lower and not clustered toward the stem apex nor distinctly overtopping the heads. var. *angustifolia*

Plants short (3-8 cm, rarely taller); the heads closely aggregated, sessile or on short pedicels (to 2 cm); cauline leaves somewhat broader and the margins irregularly repand denticulate, crowded on the short stem and overtopping the heads. . var. *yukonensis*

3a. *S. angustifolia* (Willd.) DC. var. *angustifolia*

Serratula alpina angustifolia L., Sp. Pl. 817. 1753.
Serratula angustifolia Willd., Sp. Pl. III, 1642. 1803.
 Further synonymy is given by Hultén (1950).

Chromosome number. $2n = 26$ (Johnson and Packer 1968; Zhukova 1969).
 $4n = 52$ (Packer 1964; Mulligan and Porsild 1969).

The diploid counts were determined from plants from northeastern Asia and northwestern Alaska; the tetraploid counts were made on plants of the Ogilvie Mountains and the Richardson Mountains of the Yukon Territory. From these limited data it appears that the species is probably diploid in Asia and entered North America as a diploid, but has become tetraploid as it moved farther into North America.

Canadian distribution. Yukon and the Northwest Territories. The species has recently been mapped by Porsild (1966), and some of these records are included in our maps.

The typical variety is rather common and has been collected on tundra and mountain slopes, and in open spruce and birch woods.

- 3b. *S. angustifolia* (Willd.) DC. var. *yukonensis* Pors., Nat. Mus. Can. Bull. 101:28. 1945. (Type: Wynne-Edwards 8403, Mile 111E, Canol Road, N.W.T., July 25, 1944-CAN!)

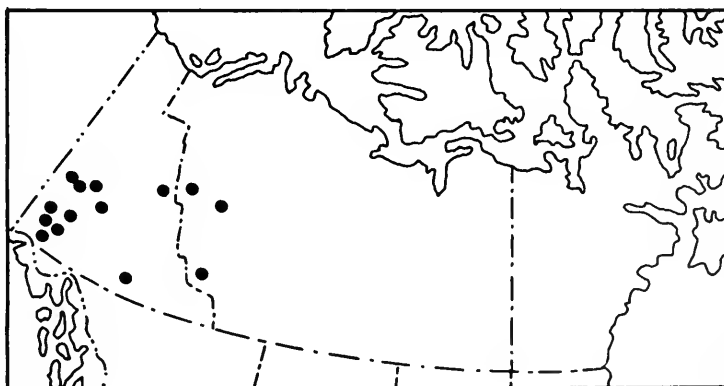
Saussurea viscida Hult. var. *yukonensis* (Pors.) Hult., Fl. Alaska & Yukon 1629. 1950.

This variety differs from the typical in one or more of the following characters. Specimens that grade into the typical variety occur. Plants of the variety *yukonensis* are short, usually within the range of 3-8 cm but some taller specimens (18 cm) are found. The heads of *yukonensis* are more closely clustered, some being sessile, some on short pedicels. The involucreal phyllaries tend to be subequal in length, rather than regularly and progressively longer from outer to inner, as in the variety *angustifolia*. The leaves of *yukonensis* are usually broader and the margin more repand denticulate than in the typical. The leaves appear to be crowded on the short stem and the upper leaves distinctly overtop the flower heads. The crowded, sessile heads and the broader, more dentate leaves may be the most distinctive characters of *yukonensis*.

Chromosome number. No counts have been reported for this variety.

Canadian distribution. Yukon and Northwest Territories. Most collections have been made in the Yukon Territory, on mountains at elevations of 1,200-1,800 m, where the plants are found on alpine slopes, in moist habitats such as peat or damp turf.

The variety occurs also in adjacent Alaska where it has been found to the northern and western limits of the state (Porsild 1966).



4. *S. americana* D.C. Eaton, Bot. Gaz. 6:283. 1881.

Saussurea alpina var. *cordata* Kurtz, Bot. Jahrb. 19:354. 1894.

Common name. American sawwort

Tall herbaceous plant, usually 3-10 dm high. Stem simple, slender, terete, glabrous, sometimes winged from the shortly decurrent leaf bases, branched near the top, each branch bearing a few heads, the heads forming a capitate cluster or, if more numerous, a corymbose group. Lower to middle leaves ovate to ovate-lanceolate, petiolate, base cordate or truncate to cuneate, apex attenuate and acute, margin dentate; upper leaves smaller, lanceolate, sessile and sometimes shortly decurrent, finely dentate or subentire; leaves glabrous above, lightly arachnoid below. Head about 18 mm high, involucre 9-10 mm high, 4-5 mm broad. Involucral phyllaries in 3-4 progressively longer series, the outer phyllaries ovate, 2 mm broad, stiff, margin entire, dark-pigmented and often with arachnoid tufts; inner phyllaries longer and lanceolate. Flowers purple, corollas 11-12 mm long, tube 6 mm, narrow, throat much broader, lobes 3-4 mm long. Anthers 5 mm long. Stigma bifid, lobes 1.5 mm. Pollen 3-pored, diam 50 μ m. Achenes 4-6 mm, narrowly oblong, light brown. Pappus 10 mm, white, plumose.

Native distribution. Native to two widely separated areas: mountains of northwestern United States; Alaska, Yukon, and adjacent northern British Columbia.

Canadian distribution. Yukon and British Columbia. The species is rare and has been collected just north of the Yukon – B.C. border, in the Queen Charlotte Islands, B.C., and in southern British Columbia near Creston, just north of the B.C. – Idaho border. These northern and southern locations appear to be on the margins of the two regions in which the species occurs.

SILYBUM

Silybum Vaill. ex Adans., Fam. II, 116. 1763. *Nomen conservandum*. (*Mariana* Hill, Veg. Syst. IV, 19. 1762.)

Tall annual or biennial herbs. Leaves large, elliptic to elliptic-lanceolate, irregularly pinnately lobed, margins crinkly, spiny, surface green and mottled with lighter areas. Heads large, involucral phyllaries glabrous, ovate-lanceolate, with apical and marginal spines. Florets similar, tubular, perfect; stamen filaments united laterally into a tube. Receptacle flat, solid, covered with setae. Pappus white, silky, nonplumose.

The genus consists of two species: *S. marianum* of extensive Eurasiatic distribution, and *S. eburneum* in Spain and Algeria. The former species has escaped from gardens in North America.

Uses. *Silybum marianum* has been widely used in Europe for food and medicine, probably more so than any other of the thistles. The young stalks, leaves, and heads are boiled and eaten as vegetables, similar to cabbage and artichoke. The seeds are food for birds. Boiled young plants used to be eaten as a springtime blood cleanser, as cures for jaundice and other liver troubles, and as a demulcent in catarrh and pleurisy. An infusion of roots and seeds was also thought to be effective against jaundice and stones. Leaves were used as poultices. The fruiting heads, rich in oils and tannins, were used as an extract or as a poultice for chest pains and other pains. Some medicinal uses were superstitious: a root worn around the neck was thought to protect against snakes and many diseases; seeds were thought to cure hydrophobia (Hegi 1929; Grieve 1931).

S. marianum (L.) Gaertn., Fruct. II, 378. 1791.

Carduus marianus L., Sp. Pl. 823. 1753.

Carduus Mariae Crantz, Inst. I, 248. 1766.

Mariana mariana Hill, Hort. Kew 61. 1768.

Mariana lactea Hill, Herb. Brit. I, 75. 1769.

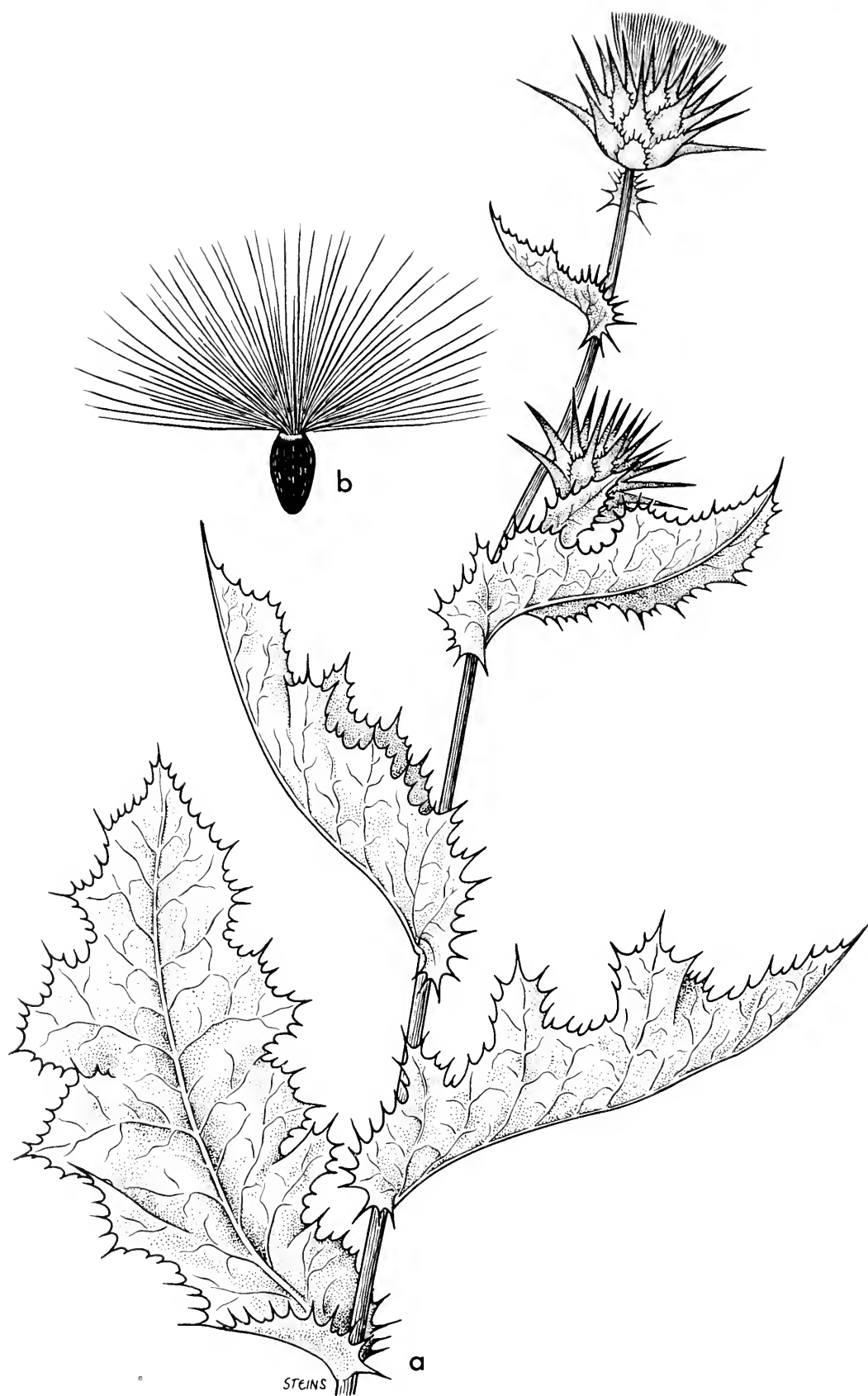
Cirsium maculatum Scop., Fl. Carn. 2nd ed., II, 130. 1772.

Carthamnus maculatus (Scop.) Lam., Encycl. meth. I, 638. 1789.

Silybum maculatum (Scop.) Moench, Meth. 555. 1794.

Common name. Milk thistle, lady's thistle; silybe, chardon Marie

Tall (6-15 dm) coarse winter annual or biennial herb. Stem erect, branched, thick, longitudinally ridged, lightly arachnoid; leaves alternate, numerous, especially on the lower parts of the plants. Lower leaves elliptic in outline, to 60 cm long, 30 cm broad, pinnately lobed (few large irregular lobes) and short petiolate; upper leaves progressively smaller and less lobed



Silybum marianum. **a**, habit, $\times \frac{1}{2}$; **b**, achene with pappus, $\times 2$.

or entire; elliptic to lanceolate-ovate, sessile or, finally, auriculate-clasping. Leaf margins crinkly, shallowly and irregularly dentate and spiny; marginal spines slender, to 5 mm. Leaves glabrous on both surfaces, the veins lighter in color so that the leaves appear distinctly mottled. Flower heads ovate; 4-5 cm high and about as wide, single on the branches. Involucre glabrous, phyllaries firm-textured; outer phyllaries about 1 cm broad at base, 4 cm long, ovate-lanceolate below with numerous marginal spines, the upper half lanceolate, spine-tipped, spreading; inner phyllaries equaling or shorter than the outer, with subterminal spinous dilation; innermost phyllaries usually shorter, lanceolate, unarmed. Receptacle flat, solid, covered with white setae. Flowers all tubular, perfect, 29-34 mm long including the narrow 5-6 mm lobes; corolla reddish purple. Anthers 6 mm long, the filaments united into a tube. Pollen diam 55 μ m. Pappus 15-20 mm, white, silky, not plumose, deciduous. Achenes 6-7 \times 3.5 mm, body smooth, glossy, dark brown with narrow yellow apical collar.

Chromosome number. $2n = 34$ (Larsen 1956; Heiser and Whitaker 1948; Skalinska et al. 1959; Moore and Frankton 1962a).

Native distribution. Southern Europe, from Canary Islands, Spain, to southern Russia, Asia Minor, Persia, North Africa. It has been introduced and escaped in northern Europe, England, and Scandinavia. It is also an escape in North and South America.

Canadian distribution. Milk thistle is rather ornamental and is sometimes grown, escaping occasionally into the surrounding area. Correspondence received with specimens sent to us for identification indicates that seed of Milk Thistle was present in seed packets of garden flowers and vegetables and has been introduced into gardens by this means. One correspondent reported that one seed of a lot known to be 27 years old had germinated. Probably this species does not persist long outside the garden and its surroundings. It flowers from late July until frost.

Canadian records are not abundant: we have seen collections from Nova Scotia, New Brunswick, Quebec, Ontario, Saskatchewan, and British Columbia. In addition, we have identified as this species plant parts sent from Manitoba and Alberta.

Rousseau (1968) states that Milk Thistle was collected on Vancouver Island, B.C., in 1887 by Macoun. This is the earliest record known.

ONOPORDUM

***Onopordum* L., Sp. Pl. 827. 1753.**

Tall, coarse, spiny, annual or biennial herbs with large solitary flower heads. Flowers tubular, perfect. Stems winged from the decurrent leaf bases. In most characters, *Onopordum* is similar to *Cirsium* but is distinguished by the fleshy receptacle that contains many honeycomb-like cells, each containing one ovary. The pappus is nonplumose.

Onopordum consists of approximately 20 species found in the Mediterranean region, extending eastward to Persia. One species is found in Canada as a naturalized garden escape.

Uses. First-year roots and young shoots of *O. acanthium* have been used as a vegetable in southern Europe; immature flower heads are also edible and are rather like artichoke. Fruits contain an oil (thistle oil), which can be burned. The pappus hairs have been woven into "thistle cloth." The plant was once believed to have medicinal value as well: expressed juice has been used in the treatment of mange and skin rash (Hegi 1929).

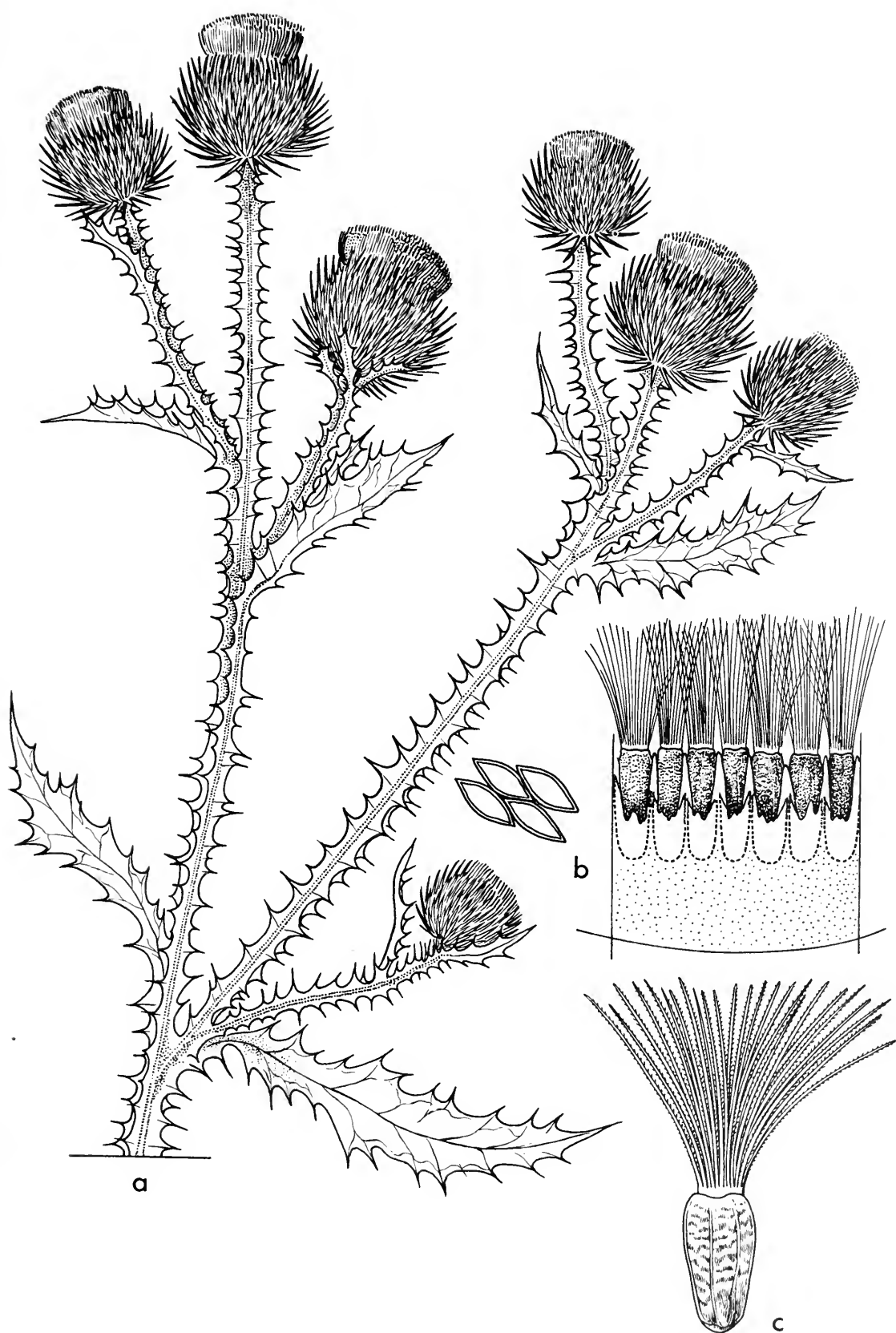
***O. acanthium* L., Sp. Pl. 827. 1753.**

O. acanthifolium Gilib., Fl. Lithuan. III, 190. 1781, non C. Koch

Acanos spina Scop., Fl. Carn. 2nd ed., II, 132. 1772.

Common names. Scotch thistle, cotton thistle; acanthe sauvage,
chardon aux ânes

Coarse biennial herb to 2 m high. Stem branched, woody, ridged and with conspicuous spiny-margined wings; stem and wings densely tomentose. Leaves alternate; lower leaves elliptic, to 6 dm long, 3 dm wide, sessile to petiolate; upper leaves smaller, linear-elliptic, the base decurrent, the margins shallowly and irregularly toothed and bearing few spines (to 5 mm), tomentose above, densely white tomentose below, the decurrent leaf bases extending to the next lower leaf. Flower head usually single on a branch 3-5 cm high, spherical. Involucre about four-fifths the height of the head; phyllaries lightly to densely tomentose; outer phyllaries 2 mm broad at base, lanceolate, tapering to a slender 4-5 mm spine, stiff, spreading; innermost phyllaries generally similar but more flexible, flatter and with shorter, thinner spines. Receptacle flat, fleshy, deeply alveolate (the achenes set in pits formed by chaff-like partitions, some of which are spinous-tipped), but receptacle not setose. Flowers purple; corollas 19-26 mm, tube 10-15 mm, limb 9-11 mm, including the 4-8 mm lobes. Anthers 7-8.5 mm long; sterile tips 2-2.5 mm, narrow, lanceolate; caudal appendages short (0.2-0.3 mm). Pollen diam 51 μ m. Stigma 4.5-6 mm long. Pappus 6-10 mm, setae unequal, sordid, not plumose. Achenes 4.5 \times 2 mm, light brownish gray, transversely wrinkled.



Onopordum acanthium. **a**, habit, $\times \frac{1}{2}$; **b**, section through receptacle: *left*, transverse; *right*, longitudinal, $\times 3$; **c**, achene with pappus, $\times 4$.

Chromosome number. $2n = 34$ (Poddubnaja-Arnoldi 1931; Skalinska et al. 1959; Moore and Frankton 1962a).

Native distribution. Europe, north to Scandinavia, England, southern Scotland, east to central Russia and Persia.

Canadian distribution. This species has been found in Canada since the 1870's. It has been collected in New Brunswick, Nova Scotia, Quebec, Ontario, and British Columbia, but is common only in Ontario where it is regarded as a weed (Montgomery 1956). It is widespread in southern Ontario, and serious infestations in Huron Co. have been known for the past 20 years.

Scotch thistle is usually found in light, well-drained, sandy or stony soil, such as pastures, roadsides, and waste land.

CENTAUREA Knapweed, star thistle; centaurée

***Centaurea* L., Sp. Pl. 909. 1753.**

The generic characters vary with the delimitation of the genus that is accepted. The following description is based on a broad interpretation of *Centaurea*.

Annual, biennial, or perennial herbs, rarely subshrubs. Leaves alternate, sometimes entire, usually pinnatifid, not spinous. Heads of various sizes, many-flowered, florets 5-parted; florets of a head either all perfect and similar, or the marginal florets sterile and larger than the perfect central florets. Involucre ovoid or globose; phyllaries eglandular; phyllary margins various — entire, fringed, or spinous or the phyllary tip expanded into a broad appendage. Pappus of bristles or narrow scales or the pappus reduced or absent. Anthers with or without caudal appendages. Receptacle bristly. Achenes ovoid or oblong, compressed or 4-angled, the hilum (point of attachment) lateral or, in species sometimes referred to segregate genera, basal-oblique.

Uses. Several species have been used medicinally in Europe. The root and seed of *C. jacea*, *C. nigra*, and *C. scabiosa* were widely used. The material was mixed in an ointment for the treatment of wounds and bruises. Decoctions were taken for the relief of coughs and catarrh and as a tonic, diuretic, and diaphoretic. Powdered seeds of *C. calcitrapa* and *C. solstitialis* were taken with wine as a remedy for stones; stem tips of *C. minor* were eaten for stomach complaints and asthma (Grieve 1931; Hegi 1929). Ingestion of *C. solstitialis* and *C. repens* has recently been reported to cause the usually fatal Chewing Disease, due to brain lesions, in horses. The disease has been found in the western United States (Young et al. 1970). Some knapweeds have been used in commerce: *C. acaulis* was a source of a yellow dye in Algeria and *C. salmantica* provided a long silky fiber. Approximately 12 species are garden ornamentals.

The only treatment of the entire genus is now more than a century old and since then, many new species have been discovered. The recent Flora U.S.S.R. (Klokov et al. 1963) estimates that the genus consists of 530-550 species. The native range of the genus is centered in the Mediterranean region, and extends eastward through southern Russia, the Caucasus Mountains, and Iran, almost to India. Species occur as introductions in Asia beyond this range. Two species are native to the southwestern United States and several occur in South America. Fifteen Old World species are naturalized in Canada and about 12 additional introductions are found in the United States.

Only a monographic study can resolve the many problems of interspecific relationships and synonymy. It has been impossible to give complete synonymy here and we have listed only those synonyms that are used rather frequently and the disposition of which is reasonably clear. Reference to works that contain extensive lists of synonyms have often been given. These usually

cover a certain geographic area only and may not be complete; they are, however, a guide to further study.

Disagreement exists between botanists regarding the delimitation of *Centaurea*. Certain groups of species are treated as sections of the genus *Centaurea* by some authors but by other botanists are recognized as distinct segregate genera. Only one of our species, *C. repens*, is concerned with this problem: it has been referred to the genus *Acroptilon* by many botanists.

KEY TO THE SPECIES

- A Phyllary margins spinous or fringed but not chartaceous and entire; attachment scars of achenes lateral; pappus absent or short (not over 5 mm).
 - B Outer involucre phyllaries bearing a strong terminal spine which is much longer than lateral spines, if these are present.
 - C Terminal spine of phyllaries more than 10 mm long.
 - D Terminal spine stout, 15-25 mm long; cauline leaves pinnatifid; flowers purplish to pink.1. *C. calcitrapa*
 - D Terminal spine slender, to 30 mm long; cauline leaves entire, narrowly elliptic; flowers yellow.2. *C. solstitialis*
 - C Terminal spine of phyllaries less than 10 mm long.
 - E Terminal spine bearing at its base a pair of lateral spines, in addition to shorter spines on the margin of the phyllary; flowers yellow.3. *C. melitensis*
 - E Terminal spine lacking a pair of basal spines, smaller spines being on the margin of the phyllary only; flowers usually white, sometimes yellow or pinkish mauve.4. *C. diffusa*
 - B Outer involucre phyllaries lacking a strong, conspicuous terminal spine.
 - F Phyllaries bearing an apical appendage (an abrupt expansion of the phyllary, distinctly broader than the phyllary base).
 - G Involucre about as long as broad; phyllary appendages broad, covering the adjacent phyllary blades.
 - H Appendages of outer and mid phyllaries entire or chartaceous and lacerate, but not pectinate.5. *C. jacea*
 - H Appendages of outer and mid phyllaries pectinate (at least partly).
 - J Pappus present (short, 0.5 mm, but fully developed); appendages black or dark brown, the fine marginal processes completely covering adjacent phyllaries and 2-3 times the width of the phyllary blade; heads eradiate.6. *C. nigra*

- J Pappus absent (or a few short bristles); appendages lighter brown, usually chartaceous and lacerate or pectinate or variable lacerate-pectinate, appendages completely covering adjacent phyllaries; heads usually radiate, rarely eradiate 7. *C. × pratensis*
- G Involucre longer than broad; appendages small and triangular, not covering adjacent phyllary blades 8. *C. nigrescens*
- F Phyllaries lacking an apical appendage.
 - L Phyllaries pectinate.
 - M Heads large; involucre 15-20 mm high 9. *C. scabiosa*
 - M Heads small; involucre to 12 mm high.
 - N Involucre 4-6 mm broad, distinctly longer than broad, the base usually tapering; heads paniculate on stiffly diverging branches 10. *C. paniculata*
 - N Involucre 6-8 mm broad, ovoid, the base rounded; heads in corymbs or corymbose panicles; branches lax 11. *C. maculosa*
 - L Phyllaries lacerate, not pectinate.
 - O Involucre about 15 mm high; achenes 3.5-4 mm long, pappus 3-4 mm long; leaves linear-lanceolate, to 5 mm wide. . . 12. *C. cyanus*
 - O Involucre 20-25 mm high; achenes 6 mm long, pappus 0.5 mm; leaves elliptic, broader, to 10 mm wide. 13. *C. montana*
- A Phyllary margins chartaceous, entire; attachment scar of achene oblique-basal; pappus long (8-10 mm) 14. *C. repens*

1. *C. calcitrapa* L., Sp. Pl. 917. 1753.

Synonymy is given in Flora U.S.S.R. XXVIII, 575.

Common names. Star thistle, caltrops; chausse-trape

Annual or biennial herb, to 6 dm high. Plant freely and divaricately branched, the stems thin, wiry, pale, glabrous. Heads borne singly among the leaves on short peduncles subtended by a pair of leaves. Flowers purplish. Leaves elliptic in outline, deeply pinnatifid almost to the midrib, segments linear-lanceolate, remote, 2-3 mm broad, margins toothed-incised, not spiny; leaves lightly pubescent. Head 20 mm high, 5-6 mm broad. Involucre 15 mm high, with long, spreading, stout spines; involucre composed of 10-12 phyllaries, oval, coriaceous, glabrous, topped by a long (to 20 mm) stout, rigid, terete spine and often with 4-6 shorter spines beside or on the base of



Centaurea. **a-b**, *C. calcitrapa*. **a**, habit, $\times 1$; **b**, outer phyllary, $\times 2$. **c-d**, *C. solstitialis*. **c**, habit, $\times 1$; **d**, outer phyllary, $\times 2$. **e-f**, *C. melitensis*. **e**, habit, $\times 1$; **f**, outer phyllary, $\times 3$. **g-h**, *C. diffusa*. **g**, habit, $\times 1\frac{1}{2}$; **h**, outer phyllary, $\times 4$.

the terminal spine. Corolla 15-16 mm long; tube 8 mm, lobes 2.5-3 mm. Stigma 2 mm long; anthers about 6 mm, filaments woolly (short hairs). Pollen diam 55 μ m. Achenes 3×1.5 mm; pappus none.

Chromosome number. $2n = 20$ (Vigrioli 1945; Heiser and Whitaker 1948; Guinochet 1957b; Guinochet and Foissac 1962).

Native distribution. Atlantic and northern Europe, Mediterranean region, Balkans, and Asia Minor.

Canadian distribution. This species is known from southwestern Ontario and from Vancouver Island, B.C. It has been collected occasionally since 1852.

A similar species, *C. iberica* Trev., is distinguished from *C. calcitrapa* by the presence of a pappus of stiff white bristles 1-2 mm long. *C. iberica* is not known in Canada but is naturalized in the southwestern United States.

2. *C. solstitialis* L., Sp. Pl. 917. 1753.

Synonymy is given in Flora U.S.S.R. XXVIII, 571-572.

Common names. Yellow star thistle, Barnaby's thistle; centaaurée du solstice

Annual or more usually biennial herb to 10 dm high. Plant erect, freely branched, the stems thin, wiry and winged, gray, woolly. Flower heads borne singly on branch tips; flowers yellow. Basal leaves lyrate; stem leaves narrow, linear, entire, gray, woolly, the bases decurrent, forming the stem wings. Head about 20 mm high; involucre about 13 mm high, 8 mm broad, globose, constricted above by the appressed inner phyllaries. Outer phyllaries ovate, subcoriaceous, arachnoid, the apex slightly dilated and terminated by a long (to 30 mm), slender, round, yellow spine, bearing 2-4 short lateral spines at the base of the primary spine. The phyllaries progressively larger and bearing longer spines from the base to the top of the involucre. Inner phyllaries unarmed, tips tapering and usually dilated and chartaceous. Corolla 16 mm; tube 8 mm, lobes 3-5 mm. Stigma 2 mm; anthers 6 mm long, filaments papillose. Pollen 3-pored; diam 31×34 μ m; polar diam 32-34 μ m; walls granulose. Achenes 4×1.5 mm, glossy, stramineous with some darker brown striations. Pappus of slender white bristles 2-5 mm long.

Chromosome number. $2n = 16$ (Heiser and Whitaker 1948; Guinochet 1957b; Guinochet and Foissac 1962; Runemark 1967).

Native distribution. South-central Europe, Mediterranean region, Balkans, Asia Minor, Iran, Turkish Armenia.

Canadian distribution. This species is not weedy in Canada. It has been

infrequently collected since 1896 in southwestern Ontario and is known also from Manitoba and Saskatchewan. It is widespread in the United States and is weedy in California.

3. *C. melitensis* L., Sp. Pl. 917. 1753.

Common names. Maltese centaury; croix de malte

No synonyms in modern use.

Annual herb, 2-5 dm high. Stem branched, erect, thin, winged, angled, gray-green, slightly asperous. Basal leaves narrowly obovate, to 7 cm long, 1.5 cm broad, lobed almost the midrib, lobes few, remote, lanceolate; stem leaves narrowly obovate or lanceolate, mostly entire, sometimes weakly toothed, ascending, bases decurrent, forming the stem wings. Leaves gray-green, covered with a dense mixture of long, very fine hairs and short, rather stiff, curled multicellular hairs, sometimes scabridulous. Flower heads 1.2-1.5 cm high, borne singly or in small irregular groups (2-5) at the tips of branches and on short branches along the main axes, flowers bright yellow, involucre ovate, about 1 cm broad, 1 cm high. Outer phyllaries coriaceous, glabrous, ovate, about 2 mm wide, stiff; spreading apical spine to 8 mm long, with 2-3 pairs of shorter spines at apex of phyllary, lateral to the primary spine, also a pair of lateral spines on the primary spine, about one-third from the base; innermost phyllaries lanceolate, longer, with terminal spine only or merely pointed, often with chartaceous dilation at apex, phyllary tips and spines often purplish or brownish tinged. Corollas 8-11 mm long; tube 4-5 mm, lobes 1.5-2 mm. Anthers 2.5-3.5 mm long, tails absent. Pollen diam 31-34 μm in polar view, 3-pored, walls thin, smooth. Achenes 3×1 mm, gray, with regular narrow longitudinal stripes; pappus 2-3 mm.

Chromosome number. $2n = 36$ (Chiappini 1954). $2n = 24$ (Guinochet 1957b; Guinochet and Foissac 1962 — for var. *apula*). Covas and Schnack (1947) reported a count of $2n = 22$, but their drawing shows 24 somatic chromosomes.

Native distribution. Southern Europe, from Portugal to the southern Balkan peninsula, North Africa, Madeira and Canary Islands; introduced into northern Europe.

Canadian distribution. This species is known only from the southern part of Vancouver Island, B.C. It has been found at Nanaimo and Esquimalt. The first collection was made in 1887. Howell (1959) records that the species was introduced into California during the Spanish – Mexican occupancy, before 1840. It is now widespread in the western states from Texas to the Canadian border.

4. ***C. diffusa*** Lam., Encycl. meth. I, 675. 1783.

C. parviflora Bess., Enum. Pl. Volhyn. 35. 1822, *nec* Desf.

Annual, biennial, or short-lived perennial herb to 6 dm high. Stem thin, much-branched, stiff, angled, gray-green, asperous. Basal leaves deeply twice-pinnately divided to the midrib, segments remote, rather linear; upper leaves with fewer divisions or entire; leaves gray-green, thick and firm, asperous, lightly woolly; margins revolute. Flower heads very numerous, borne singly on the leafy-bracted, corymbosely branched stems. Flowers usually white but sometimes yellow, pink, or mauve. Head 14-16 mm high; involucre about 1 cm high, 4-5 mm broad, ellipsoid-cylindric. Outer phyllaries coriaceous, glabrous, with a waxy secretion of minute globules; ovate-lanceolate, with a terminal, spreading, fine stiff spine, to 7 mm long and with also 4-5 pairs of shorter lateral spines; inner phyllaries thinner and with shorter spines or unarmed. Corollas 9-11 mm long; tube 4-5 mm, lobes 4.5-5 mm. Anthers 5-5.5 mm. Pollen diam 34-36 μm in polar view, 3-pored, walls thin, smooth with only remote granules. Stigma 1 mm long. Achenes $2.3\text{-}2.5 \times 1$ mm, glossy brown; pappus absent or short, to 1 mm.

Chromosome number. $2n = 18$ (Moore and Frankton 1954; Guinochet and Foissac 1962).

Native distribution. Balkans, southern Russia, Asia Minor; introduced into central and southern Europe.

Canadian distribution. *Centaurea diffusa* is known mainly from British Columbia, where it occurs in the dry interior: in the Fraser River Valley, in the Kamloops Valley, and in the Okanagan Valley to the United States border. The species extends from Grand Forks, where it is abundant, east to Cascade; more recently it has been collected near Kimberley and Cranbrook. A few records from southern Alberta are known. Howell (1959) notes that the earliest collection from the western United States seen by him was made in 1907 in Washington State. A closely related species *C. virgata* Lam., is found in California (Howell 1959) but is not known in Canada. This species is distinguished from *C. diffusa* by smaller heads ($12\text{-}13 \times 2\text{-}3$ mm), larger seeds (2.5-3.5 mm), and a longer (to 2.5 mm) pappus. It is reported that *C. virgata* is perennial and the flowers are pinkish or lavender.

5. ***C. jacea*** L., Sp. Pl. 914. 1753.

No commonly used names are in synonymy. For synonyms, see Flora U.S.S.R. XXVIII, 444-445. This is a highly variable taxon. It is often divided into several infra-specific taxa or treated as four species by European authors. We have not attempted to distinguish between these in our introduced populations and treat all as a single species, *s. lat.*

Common names. Brown knapweed, rayed knapweed; centauree jaccée, jaccée des prés

Perennial herb to 1.5 m high. Stem slender, green, ridged, sometimes purple-striped, arachnoid, corymbosely branched, the branches terminated by a single head. Basal leaves oblanceolate, base tapering, slender, entire or sinuate to pinnatifid; stem leaves lanceolate, entire to shallowly sinuate; leaves glabrate to lightly arachnoid on both surfaces, texture firm, asperous due to minute appressed cartilaginous hairs on the margins and on veins of the lower surface. Flower heads radiate (with longer, sterile, marginal flowers and shorter, perfect, central flowers) 4 cm in diam, 20-25 mm high, flowers rose purple. Involucre subglobose, about 15 mm high and equally wide. Phyllaries ovate-lanceolate to lanceolate, bearing a broad appendage (a large, apical dilation of the phyllary); appendage to 6 mm broad, rectangular to oval, concave, chartaceous, white to light brown, margin entire, erose or lacerate. Appendages overlap adjacent phyllaries. Marginal florets sterile, about 21 mm long, lobes 10 mm; central florets fertile, 14-15 mm long, tube 3.5-5 mm, lobes 4-5 mm. Anthers 6-6.5 mm long. Pollen 36-38 μm in diam, 3-pored, spherical; walls thin (ca. 3 μm), remotely apiculate (few, small points). Stigma clavate, ca. 2 mm long. Achenes 3-3.2 \times 1.2-1.3 mm, compressed, obovoid or ellipsoid; pale gray or light brown, covered with short, fine hairs. Pappus absent. Hegi (1929) recognized six subspecies in the native range. Canadian plants generally fall in the subspecies *jacea*, but some approach, and may be, the subspecies *angustifolia*. It is possible that several European entities have hybridized in North America and that the variability of our populations is unlike that of European populations. The various subspecies have distinctive ranges in Europe; no such geographical separation is known in Canada. Hegi separates the above two subspecies as follows.

The subspecies *jacea* is unbranched or bears short branches on the upper half of the stem. The branch leaves are usually shorter than those of the stem. The leaves are green, elliptic-lanceolate to lanceolate, lower leaves occasionally lobed.

The subspecies *angustifolia* (Schrank) Gugler is a tall plant (1.5 m) bearing many slender branches. The leaves of the branches are usually longer than the stem leaves. Leaves are narrow-lanceolate to linear, arachnoid to tomentose.

Chromosome number. $2n = 22$ (Guinochet 1956a: ssp. *angustifolia*; Guinochet 1957b: ssp. *angustifolia* var. *diploidea*; Gardou 1962: ssp. *angustifolia*). $n = 22$ (Sorsa 1962). $2n = 44$ (Roy 1937 and several later authors; Guinochet 1957b: ssp. *Ropalon* and four varieties of ssp. *angustifolia*). $2n = 22, 44$ (Moore 1968).

Both the diploid and tetraploid number are found within this species complex. Probably a single number is characteristic of each of the infra-specific taxa. Some counts have been reported under *C. jacea* s. lat. We have found both numbers in Canadian collections, which we class as ssp. *jacea*. However, they approach ssp. *angustifolia* and may be hybrids that have arisen in North America.

Native distribution. Southern Scandinavia, Atlantic and Central Europe, northern Italy, and the Balkans.

Canadian distribution. Brown knapweed is naturalized in Quebec and Ontario and has also been collected in British Columbia. It is most common in southwestern Quebec south of the St. Lawrence River, and in southwestern Ontario, and is usually considered to be a pest in these areas. Only one collection from British Columbia is known.

Brown knapweed is found in well-drained soils such as roadsides, field margins, pastures, and waste ground. It flowers in July and August.

Rousseau (1968) records an 1850 collection from Ascot, Sherbrooke Co., Que. The plant is very abundant in Missisquoi Co., Que., where it is called "bull clover" by farmers and is welcomed as a source of hay and forage. Unpublished information in our files shows that the plant was introduced about 1880 by a farmer near Frelighsburg, Missisquoi Co., for the benefit of his honey bees.

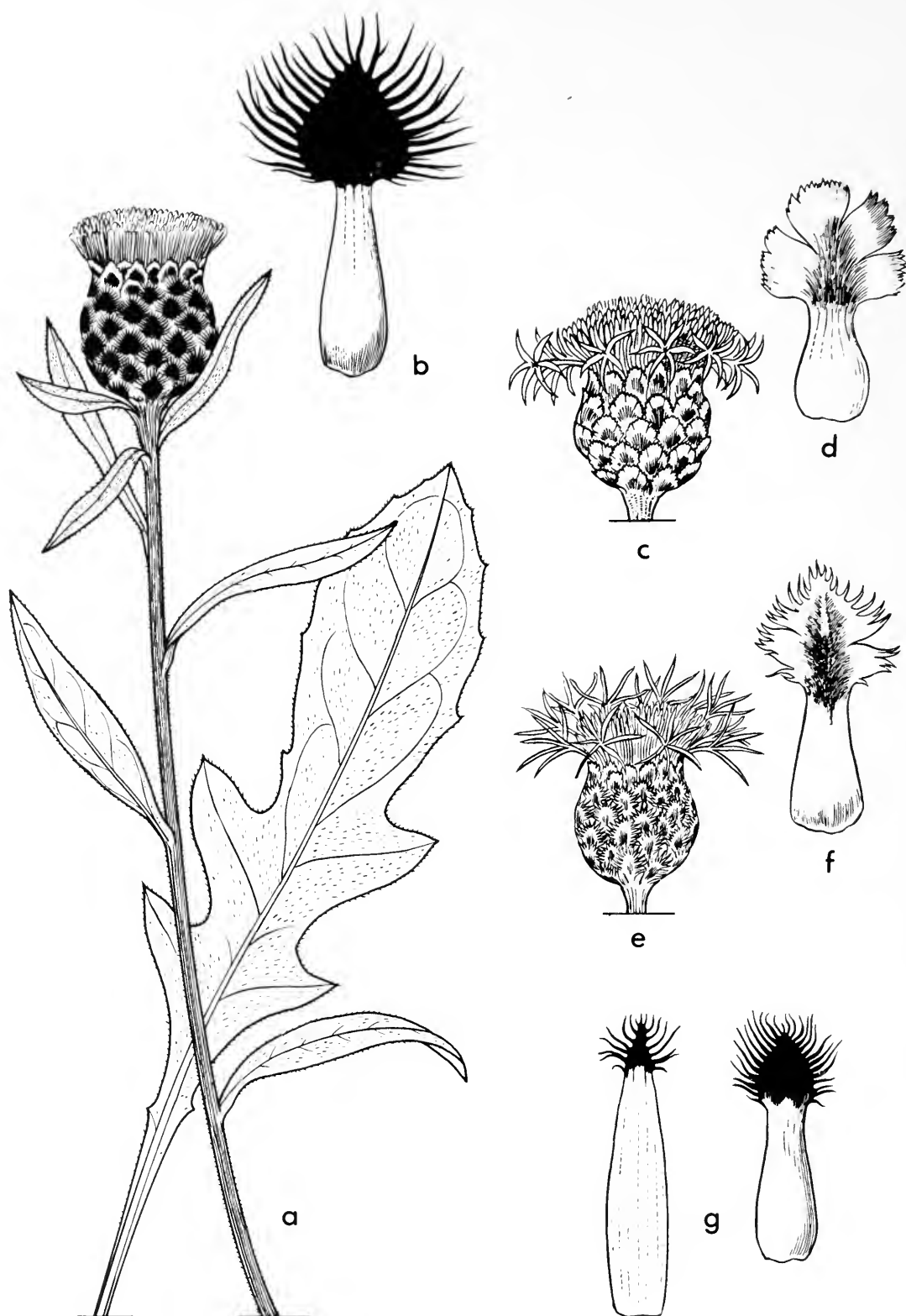
6. *C. nigra* L., Sp. Pl. 911. 1753.

Numerous synonyms apparently exist and the interpretation of many names presents great problems. Marsden-Jones and Turrill (1954) discuss the typification of *C. nigra* and their understanding of some of the confused, related names. *Centaurea nigra* has been treated as a variety of *C. jacea*; for example, *C. jacea* var. *nigra* Coss. & Germ. Several subspecies of *C. nigra* are usually recognized in European literature. We have not attempted to distinguish these infraspecific taxa among Canadian populations in which different European genotypes may have mingled.

Some authors state that plants with ray-like marginal flowers occur in this species and call these the variety *radiata* DC. Marsden-Jones and Turrill (1954, p. 10) state that the type specimen of *C. nigra* has eradiate heads and that they consider that the radiate condition has been introduced into *C. nigra* by hybridization with *C. jacea*. We agree with this view. We find that radiate plants that closely approach *C. nigra* are slightly atypical in other characters as well, usually in the appendage or in the absence of pappus on the achene.

Common names. Black knapweed; centaurée noire

Perennial, sparingly branched herb to 8 dm high. Stem slender, hard, ridged, green, villous; hairs white to rusty; branches terminated by a single head; heads usually corymbosely arranged. Head consisting of perfect tubular flowers only, without ray-like marginal florets; flowers rose purple. Basal leaves oblanceolate, shallowly and irregularly pinnatifid to sinuate; upper stem leaves oblong-lanceolate, entire or slightly sinuate, pinnatifid, the uppermost leaves reduced. Leaves green, light villous above, villous below, asperous due to short harsh appressed hairs on the margins and lower surface. Head 20-25 mm high; involucre subglobose, about 15 mm high and as wide. Phyllaries lanceolate, terminated by a broad appendage that completely covers the blades of adjacent phyllaries. Appendage 3-4 times the width of the phyllary, black or dark brown, pectinate, consisting of long stiff processes



Centaurea. *a-b*, *C. nigra*. *a*, habit, $\times 1$; *b*, outer phyllary, $\times 4$. *c-d*, *C. jacea*. *c*, head, $\times 1$; *d*, outer phyllary, $\times 4$. *e-f*, *C. pratensis*. *e*, head, $\times 1$; *f*, outer phyllary, $\times 4$. *g*, *C. nigrescens*, outer phyllaries, $\times 4$.

radiating from the expanded apical region of the phyllary; appendages of the innermost phyllaries ovate, pectinate to lacerate. Flowers 14-17 mm long; tube 5-7 mm, lobes 4-5 mm. Stigma clavate 1.5-2 mm. Anthers 6-7 mm. Pollen spherical, 3-pored, 38-42 μm in diam, wall about 3 μm thick, rather smooth with numerous small spines. Achenes $3-3.5 \times 1.2-1.5$ mm, compressed, obovoid, ellipsoid; light gray or light brown, lightly pubescent (short fine hairs), pappus 0.5-1 mm, rarely incomplete.

Chromosome number. $2n = 22$ (Guinochet 1956a: ssp. *guyerii*, ssp. *nemoralis*; Guinochet 1957b: as *C. jacea* ssp. *nigra*). $2n = 44$ (Roy 1937).

Native distribution. Western Europe to the British Isles and western Norway; south to Spain and northern Italy; eastward into western Germany.

Canadian distribution. Black knapweed is common in eastern Canada and may be considered to be a weed. It has been collected extensively in Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, and Ontario.

Black knapweed flowers from mid-June to mid-September. It is found on roadsides, pastures, hayfields and waste land—usually on sandy or gravelly soil.

The white-flowered form (f. *pallens* Spenn) is rare but has been found in Nova Scotia and Quebec.

Rousseau (1968) reports that this species was collected in 1850 in Sherbrooke Co., Que. The earliest collection seen by us was made in 1879 in Ontario. Collections since the 1930's are abundant.

Centaurea nemoralis Jord. is very similar to *C. nigra* and is said by Marsden-Jones and Turrill (1954) to differ from *C. nigra* in that the stems are more branched and the branches are more slender, the leaves narrower, the heads slightly smaller, and the phyllary appendages often narrower, not completely covering the adjacent phyllary blades. Apparently this species grades into *C. nigra*. We have treated specimens showing some of the characters of *C. nemoralis* as *C. nigra* s. lat.

7. *C. \times pratensis* Thuill., Fl. env. Paris, 444. 1799.

C. nigra var. *radiata* DC., Fl. Franc. VI, 460. 1815.

This species is considered to be a hybrid between *C. nigra* and *C. jacea*. This hybrid occurs commonly in nature in Europe and several careful studies of the populations have been made. Marsden-Jones and Turrill (1954) have studied these plants in Great Britain extensively.

Numerous species have been named from plants that are apparently of this hybrid parentage. We believe that *C. pratensis* is the oldest name applicable

to these hybrids. Other names that probably apply are *C. jungens* (Gugl.) C.E. Britton, *C. drucei* C.E. Britton, *C. monktonii* C.E. Britton, *C. suttejana* C.E. Britton, *C. nemophila* Jord. ex Nym., *C. viretorum* Jord. ex Nym.

Centaurea jacea and *C. nigra* are similar in many characters, and *C. × pratensis* shares these. *Centaurea jacea* and *C. nigra* differ conspicuously in three characters: heads radiate/eradiate; phyllary appendages lacerate and light brown/appendages pectinate and black; pappus absent/present.

In *C. × pratensis* the heads are almost always radiate. The phyllary appendages are usually pectinate and brown or very dark brown, but never black as seen in *C. nigra*. There is variation in the size and nature of the appendages of the outer phyllaries; they are usually narrower than those of *C. nigra*, the central portion darker brown than the marginal processes, which are less wiry than in *C. nigra* and vary from stiff to flexible, at the extreme being almost chartaceous and finely lacerate. Appendages of the inner phyllaries are ovate, chartaceous, ranging from pectinate to lacerate. More phyllaries with subentire, lacerate appendages are usually present than in *C. nigra*. In the latter, only the phyllaries of the innermost row have chartaceous, subentire appendages.

The achenes lack a pappus or have, at most, only a vestigial one.

Among these plants it is possible to select those that appear to be F_1 hybrids — exactly intermediate between *C. nigra* and *C. jacea*, and others that approach either parent more closely and may be backcrosses. The hybrids have usually been classified as *C. nigra* because of their pectinate appendages, but the lighter, tawny color of the appendage and the presence of ray-like marginal florets indicate their hybrid nature.

Chromosome number. $n = 22$ (Roy 1937). $2n = 44$ (Gadella & Kliphuis 1966; Moore 1968).

Canadian distribution. Collections have been seen from Nova Scotia, Quebec, Ontario, and British Columbia. Probably the first Canadian record is contained in the 1909 report of *C. nigra* var. *radiata* from Birchy Cove, Nfld. (Eames 1909).

The hybrid has been collected in Nova Scotia but only one parent, *C. nigra*, has been found in that province. Black knapweed is frequently found in the Atlantic Provinces but pure *C. jacea* is not known there. The hybrid was probably introduced as seed into Nova Scotia. It is also possible that *C. jacea* was introduced into a stand of *C. nigra* and was swamped in the resulting hybridization.

Marsden-Jones and Turrill (l.c., p. 184) found that hybrids were fertile, the first hybrid generation generally being more fertile than later generations. Extensive pure stands of *C. jacea* were unknown to them in England and they believed that this species was occasionally introduced from the Continent and invaded established populations of *C. nigra*. Apparently *C. jacea* did not maintain its identity under these circumstances.

8. *C. nigrescens* Willd., Sp. Pl. III, 2288. 1804.

C. vochinensis Bernh. ex Reichb., Fl. Germ. excurs. 214. 1830.

C. jacea L. var. *transalpina* Briq., Monogr. Centaurées Alpes Maritimes, p. 77. 1902.

Numerous taxa related to *C. nigra* have been described and treated at specific or infraspecific rank and variously combined by many botanists. Recent North American literature indicates that *C. nigra* and one or more of the species *C. nigrescens*, *C. dubia*, and *C. vochinensis* are naturalized introductions in Canada and the United States. The latter species is sometimes treated as a subspecies of *C. dubia*. Hegi (1929) recognizes *C. dubia*, consisting of the three subspecies *eu-dubia*, *nigrescens*, and *vochinensis* in central Europe.

Briquet (1902) recommended that the name *C. nigrescens* be abandoned because it caused confusion. However, it has been typified. Briquet records that Kerner selected the type of *C. nigrescens* from Willdenow's herbarium. Kerner found there, under *C. nigrescens*, five specimens representing three different plants. Only two of the specimens could fit Willdenow's description of a plant from Austria and Hungary, and these specimens were, in Kerner's opinion, the same as the later-described *C. vochinensis* Bernh. Briquet therefore concluded that *C. nigrescens* Willd. s. str. applies only to *C. vochinensis*, or, s. lat., to a group of related taxa. Briquet treats these as varieties of *C. jacea* L., as follows:

var. *transalpina* Briq. = *C. nigrescens* Willd. p.p. (1804), *C. dubia* Suter (1802)

var. *vochinensis* Briq. = *C. nigrescens* Willd. s. str. (1804), *C. vochinensis* Bernh. (1830)

Our plants fall into Briquet's var. *vochinensis*. We consider them to be more closely related to *C. nigra* than to *C. jacea* and prefer to treat them at specific rank, for which the oldest name is *C. nigrescens* Willd. We have not seen collections of *C. dubia* from Canada.

Perennial herb 4-10 dm high; branched above the middle, branches ascending, terminated by a single head, the heads of a stem generally in a corymbose arrangement. Stem and branches slender, firm, ridged, glabrate, lightly villous. Basal leaves oblanceolate to elliptic, base tapering, irregularly sinuate pinnatifid to two-thirds the width of the blade. Cauline leaves lanceolate or elliptic, sessile, the base rounded or acute; leaves entire or shallowly and irregularly sinuate-pinnatifid, thin, green, glabrous or often lightly pubescent below; margin asperous (minute stiff hairs). Upper leaves small, narrow, sessile, entire or subentire. Head usually eradiate but sometimes radiate, corollas reddish purple. Head 15-20 mm high, 30-40 mm wide to the tips of the radiate florets, if present. Involucre longer than broad; 12-15 mm high, 8-11 mm broad. Outer and mid phyllaries bearing a small, usually triangular appendage ($0.6-1 \times 0.6-1$ mm), which is little broader than the phyllary, dark brown or black, the thin wiry processes somewhat lighter than the central portion; phyllary bases green, sometimes purple-tinged, strongly contrasting with the small dark appendages. Tips of innermost phyllaries dilated, roundish, chartaceous and erose or entire. Sterile marginal florets, if present, about 25 mm long, lobes 10 mm. Perfect central florets 15-16 mm long; tube 7-8 mm, lobes 4 mm. Stigma 1-1.5 mm. Anthers 5-6 mm. Pollen 3-pored, diam 38-40 μ m, remotely and finely apiculate. Pappus absent or rudimentary (chafflike, 0.5 mm long). Achenes $3.2-3.5 \times 1.2-1.5$ mm, gray or light brown.

Chromosome number. $2n = 44$ (Guinochet and Foissac 1962).

Native distribution. North of the Alps from Germany to Roumania (Hegi 1929).

Canadian distribution. This species has been collected in Nova Scotia, Quebec, Ontario, and British Columbia but is not common. It has been found most frequently in southern Ontario where some extensive stands have been noted but it is not regarded as a weed. An 1878 collection from Toronto is the oldest seen. A collection made in 1966 on Vancouver Island, B.C., is our only record from that province. This knapweed is found on roadsides, pastures, orchards, and waste ground; it flowers from June to September.

9. *C. scabiosa* L., Sp. Pl. 913. 1753.

Synonymy is given in the Flora U.S.S.R. XXVIII, 503. Approximately eight subspecies have been recognized in Eurasia. Several of these are treated as separate species in the Flora U.S.S.R. Our plants are classed in the following treatment as *C. scabiosa* s. lat.

Common names. Greater centaurea, hardheads; centaurée scabieuse

Perennial herb, 3-15 dm high. Stem corymbosely branched, the leafless branches each bearing a single large head. Stem firm, green, lightly arachnoid. Basal leaves obovate in outline, deeply and irregularly pinnately segmented, sometimes twice segmented, segments narrowly elliptic-lanceolate. The stem leaves elliptic-obovate in outline. Heads radiate, flowers purple, rarely white or yellow. Heads single on naked branches, 22-30 mm high, about 5 cm broad to tips of the marginal flowers. Involucre 15-20 mm high and broad, globose ovoid. Phyllaries ovate to ovate-lanceolate with an apical fringe of thin, wiry, slightly curled processes about 1 mm long; phyllary tip black or dark brown, arachnoid, the remainder of the phyllary glabrate. Inner phyllaries longer, with a dilated dark pectinate apex. Sterile marginal flowers about 40 mm long, lobes 10 mm. Perfect flowers 20 mm long, tube 10 mm, lobes 4-5 mm. Anthers 5.5 mm; stigma bifid, 1.5 mm. Pollen 3-pored, 48-51 μm in diam, walls thin, smooth. Achenes about 5 mm long, 2.5 mm broad, fawn; pappus about 4 mm long, fawn.

Chromosome number. $n = 10$ (Poddubnaja-Arnoldi 1931). $2n = 20$ (Roy 1937). Six later authors have confirmed these counts. Gardou (1969) found the somatic numbers 20, 30, and 40 among four varieties and all three numbers in one variety. Frost (1948) found as many as 13 accessory chromosomes, in addition to the normal 20, in some plants.

Native distribution. All Europe, including England, Ireland, and Scandinavia; western Siberia.

Canadian distribution. This escape is found in pastures and roadsides, flowering in July and August. It is not abundant. It has been found in the Gaspé region of Quebec and in southern Ontario. A reported occurrence in New Brunswick (Boivin 1966-67) is an error due to a mislabeled European specimen (Boivin, personal communication).

10. *C. paniculata* L., Sp. Pl. 912. 1753.

Jacea paniculata Lam., Fl. Fr. 2nd ed. 50. 1795.

Centaurea paniculata and *C. maculosa* are closely related species and they intergrade morphologically and geographically. Many infraspecific taxa have been described in this complex by various European botanists. Rouy and Camus (1901) treated *C. maculosa* and seven other species as subspecies of *C. paniculata* and also recognized numerous other taxa of lower rank. Arènes (1949) has described the morphology and distribution of subspecies and varieties of *C. paniculata* found in Portugal.

Annual, biennial, or sometimes perennial herb, 25-70 cm high. Stem slender, erect, with numerous stiff, wiry branches that diverge widely from the main stem, the branches again branched and divergent. Stem ridged, sometimes sharply angled, grayish green, tomentose. Branches usually bearing one (sometimes 2-3) heads in an irregular or sometimes corymbose panicle. Heads radiate, florets pinkish purple, rarely white. Leaves once or twice deeply pinnately segmented almost to the midrib, to 5 pairs of irregular lobes; segments remote, narrow, oval or elongate, to 3 mm broad; upper leaves smaller, almost entire, linear-lanceolate sometimes with a few asymmetrical lobes; leaves grayish green, tomentose on both surfaces, midrib obscure. Head 14-18 mm high. Involucre about 10 mm high, 4-6 mm broad, oblong, distinctly longer than broad and usually narrowed and tapering at the base, rarely rounded. Phyllaries ovate, membranous, ribbed, usually brown or light brown and sometimes with a darker apical and marginal marking, glabrous (except for light arachnoid pubescence on the apical marking), with 4-6 pairs of fine stiff marginal cilia, to 1.5 mm long, the apical point about as long as or longer than the lateral points. Marginal flowers sterile, ray-like, about 20 mm long. Inner perfect flowers 11-13 mm long; tube 4-5 mm, lobes 2-3 mm. Stigma about 1.5 mm, clavate; anthers about 6 mm long. Pollen 3-pored, diam 34 μ m, walls minutely granular. Achenes 3 mm long \times 1 mm, brown or grayish brown; pappus white, to 2.5 mm long.

Chromosome number. $n = 18$ for five infraspecific taxa; $n = 19$ for one variety (Guinochet 1956b, 1957b).

Native distribution. Portugal, Spain, Mediterranean and southeastern France, Switzerland, Italy. Apparently *C. paniculata* occurs in more southerly and westerly localities than does *C. maculosa*.

Canadian distribution. Known only from Victoria, Vancouver Island, B.C. and apparently rare, but has persisted for many years. *Centaurea paniculata* was reported from this area by Carter and Newcombe (1921), but was later

excluded from the provincial flora by Eastham (1947), who considered the plant to be *C. maculosa*. Groh (1944) revised a Macoun collection from Victoria, originally determined as *C. paniculata*, to *C. maculosa* and therefore listed no collections of *C. paniculata* from Canada. Howell (1959) reinstated *C. paniculata* in the Canadian flora, citing two collections from Victoria (Macoun 552; Malte s.n., Aug. 1912). We have seen five collections that we consider to be *C. paniculata*. Malte s.n., July 24, 1911 (CAN); Macoun 552, Aug. 18, 1893 (CAN); Eastham DA 6177, July 29, 1939 (DAO); Connell s.n., Aug. 13, 1933 (V); Goddard s.n., May 16, 1932 (V).

11. *C. maculosa* Lam., Encycl. I, 669. 1785.

C. paniculata auct., nec L.

Most European and American authors use the name *C. maculosa* for this species. Hayek (1931) takes up the prior name *C. stoebe* L. If it is correct that the Linnean name refers to these plants, the name *C. stoebe* must be accepted. For the present we are using the more widely accepted name.

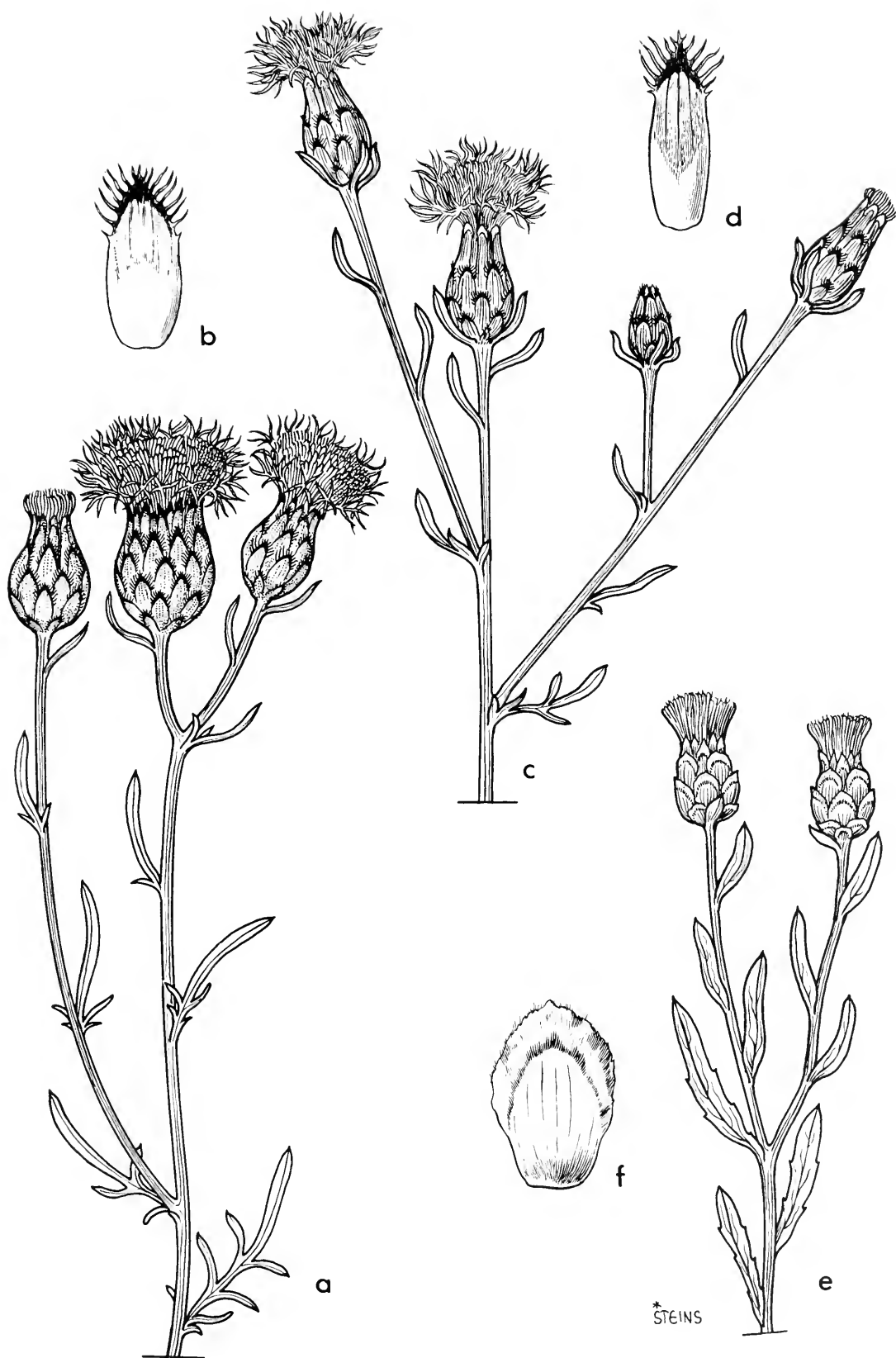
Several infraspecific taxa have been recognized under *C. maculosa* in Europe, where they have different ranges. It does not seem practical to attempt to separate our plants according to these minor characters.

Common names. Spotted knapweed; centauree maculée, centauree tachetée

Biennial, sometimes perennial herb, 2-18 dm high. Stem slender, wiry, with numerous ascending, corymbose branches each bearing a single head. Stem green, ridged, sericeous. Leaves deeply pinnately segmented to the midrib; segments remote, linear, 1-3 mm wide; lower leaves 2-3 times segmented, upper leaves once-segmented or essentially entire, linear; leaves canescent above and below, midrib prominent. Heads radiate, 16-20 mm high; flowers purple or pinkish purple, rarely white. Involucre 9-12 mm high, 6-8 mm broad, ovoid. Phyllaries ovate to ovate-lanceolate, bearing 4-8 (rarely to 12) pairs of fine stiff processes 0.5-1.5 mm long; phyllaries membranous, usually ribbed, usually with a dark brown or black marking at the tip and margin, glabrous (except for arachnoid pubescence on the terminal marking) marginal cilia usually dark brown and sometimes with lighter, whitish tips.

Marginal flowers sterile, ray-like, about 18-20 mm long; central perfect flowers 12-16 mm long, tube 6-8 mm, lobes 3-4 mm. Stigma 1.5 mm, clavate-tipped; anthers 5.5-6.5 mm long. Pollen 3-pored; diam 38 μ m, walls about 3 μ m thick, almost smooth, minutely and sparsely granular. Achenes 2.5-3.5 mm long \times 1 mm, usually 3 mm long, dark gray to black; pappus white, 0.5-1.5 mm long.

Chromosome number. $2n = 18 + (0-2B)$ (Skalinska et al. 1959, as *C. rhenana* Bor. = *C. maculosa* Lam. ssp. *rhenana* (Bor.) Gugler. $2n = 36$ (Moore and Frankton 1954).



*STEINS

Centaurea. **a-b**, *C. maculosa*. **a**, habit, $\times 1\frac{1}{2}$; **b**, outer phyllary, $\times 4$. **c-d**, *C. paniculata*. **c**, habit, $\times 1\frac{1}{2}$; **d**, outer phyllary, $\times 4$. **e-f**, *C. repens*. **e**, habit, $\times 1$; **f**, outer phyllary, $\times 4$.

Native distribution. Central Europe, northward to northern France and Germany, south to the Pyrenees, northern Italy and the northern Balkans, eastward to central Russia, Caucasus, and western Siberia.

Canadian distribution. This species has been collected in Nova Scotia, New Brunswick, Quebec, Ontario and British Columbia. It is most abundant in British Columbia, but some extensive stands in Ontario are known. Spotted knapweed is generally considered to be a weed and is a serious pest in some areas.

Spotted knapweed is commonly found along roadsides, and in pastures and hayfields; it flowers in July and August.

The first Canadian collection that we have seen was made in 1893 at Victoria, B.C. Rousseau (1968) found that it has been present in Quebec at least since 1932.

12. *C. cyanus* L., Sp. Pl. 911. 1753.

For synonyms, see Flora U.S.S.R. XXVIII, 416-417.

Common names. Bluebottle, bachelor's-button, cornflower, bluebonnets, blaver, blue poppy, thimbles, brushes, corn binks, witches' bells, hurtsicke; bleuet, barbeau, casse lunette

Annual herb, 2-10 dm high with ascending branches, each bearing a single radiate flower head. Stems slender, green, sericeous. Leaves linear or lanceolate, entire, white woolly below, upper leaves 2-3 mm broad, lower leaves to 5 mm broad. Involucre about 15 mm high, 6-8 mm broad (when fresh). Phyllaries unarmed, deltoid, ovate or lanceolate, from outer to inner, thin, membranous, glabrous, the margins chartaceous and regularly lacerate, the phyllaries and margins green or often purple-tinged. Sterile marginal florets about 18 mm long; central perfect florets about 15 mm long, tube 7 mm, lobes 4-5 mm. Corollas blue, purple, or white. Stigmas bifid, about 1 mm. Anthers 6 mm long, purple. Pollen diam 34 μ m, 3-pored, walls thin, smooth. Achenes 3.5-4 mm long, 1.5 mm broad, compressed, 1 mm thick; light and dark gray, slightly sericeous; pappus 3-4 mm long.

Chromosome number. $n = 12$ (Morinaga et al. 1929; Poddubnaja 1929); $2n = 24$ (Guinochet 1957b). Four later counts confirm this number.

Native distribution. Originally in the Mediterranean region (Sicily, Balkan Peninsula, western Asia Minor) but now over all Europe and western Asia.

Canadian distribution. This garden ornamental occasionally escapes and persists in grainfields and roadsides. It flowers in July and August. It is not a serious weed. Collections from all the provinces except Saskatchewan have been seen.



Centaurea. **a-b**, *C. cyanus*. **a**, habit, $\times \frac{2}{3}$; **b**, outer phyllary, $\times 4$. **c-d**, *C. montana*. **c**, habit, $\times \frac{2}{3}$; **d**, outer phyllary, $\times 4$. **e-f**, *C. scabiosa*. **e**, habit, $\times \frac{2}{3}$; **f**, outer phyllary, $\times 4$.

The oldest specimen seen was collected near Prescott, Ont., in July 1860. The collector (Billings — QK) noted that the plant was “common in grainfields.”

13. *C. montana* L., Sp. Pl. 911. 1753.

No common synonyms.

Common name. Mountain bluet

Perennial herb, to 8 dm high. Stem erect, usually simple but occasionally with a few short upper branches each bearing a single radiate flower head. Stem narrow-winged, green, rather fleshy, lightly pubescent. Leaves broadly lanceolate or elliptic, entire, the base decurrent; green, lightly woolly below, glabrate above, with few short multicellular hairs. Involucre 20-25 mm high, 12-15 mm broad, cylindrical-ovate. Phyllaries unarmed, ovate to ovate-lanceolate, green, glabrous, flexible, with dark brown or black lacerate margins. Marginal florets about 44 mm long; tube 30 mm, lobes 11 mm, deep blue; central florets 16 mm long, tube 6 mm, lobes 7 mm, deep blue. Stigma bifid, 1 mm; anthers 9 mm long, purple. Pollen 40-50 μ m in diam, 3-pored, walls thin, about 2 μ m thick, smooth. Achenes 6 mm long, 3 mm broad, light yellow, almost white, glossy; pappus short, about 0.5 mm.

Chromosome number. $2n = 40$ (Zhukova 1964). $2n = 44$ (Guinochet 1957a, 1957b; Skalinska et al. 1961: for ssp. *mollis*).

Native distribution. Pyrenees, Alps, mountains of central Europe north to Belgium, Carpathian Mountains.

Canadian distribution. This attractive plant is a garden ornamental and is occasionally found as an escape. It has been collected, apparently naturalized, in Newfoundland, New Brunswick, Quebec, Ontario, and British Columbia. It flowers in June and July.

14. *C. repens* L., Sp. Pl. 2nd ed. 1293. 1763.

Centaurea picris Pall., Tabl. Phys. et topogr. taur. 58. 1795.

Acroptilon repens (L.) DC., Prodr. VI, 663. 1837.

Acroptilon picris (Pall.) Boiss., Fl. Orien. 5:612, 1875.

Complete synonymy is given in the Flora U.S.S.R. XXVIII, 345.

This species is sometimes separated from *Centaurea* and placed in the segregate genus *Acroptilon*, where the correct name is *A. repens* (L.) DC. This practice is followed by the Flora U.S.S.R. *Acroptilon* is distinguished from *Centaurea* by the sub-basal, rather than lateral, attachment scar on the achene. The chromosome number of this species is one found, so far, only in those species of *Centaurea* s. lat. that have, by

some botanists, been referred to segregate genera. There is, therefore, evidence to support the recognition of the genus *Acroptilon*. We have here treated Russian knapweed under *Centaurea* because this is the more usual North American practice.

Common name. Russian knapweed

Perennial, corymbosely branched bushy herb, 2-9 dm high. Stems thin and stiff, ascending, green, canescent. Plants forming dense patches, spreading by a deep underground stem. Roots tough, dark brown or black. Rosette leaves oblanceolate, irregularly pinnately lobed or almost entire; lower stem leaves narrowly oblong to linear-lanceolate, the larger, lower leaves irregularly notched; the smaller upper leaves entire or almost so. Leaves firm in texture, lightly pilose when young and becoming glabrate. Heads eradiate 15-17 mm high; involucre 12-14 mm high, 5-7 mm broad, ovoid. Outer phyllaries ovate, glabrous, whitish green, firm, with a broad, whitish, chartaceous, finely hairy, entire border (broadest at the apex of the phyllary); inner phyllaries longer, with a dilated, more or less chartaceous, densely silky pubescence. Corolla 12.5-13 mm long; tube 6.5-7 mm, lobes 2-3.5 mm; pink or purple. Anthers 4-5.5 mm long, tails absent. Pollen diam 48-51 μm , spherical, 3-pored, walls thin, about 2 μm thick and finely granular. Stigma 3.5 mm long. Achenes 3 mm long, oval in outline and compressed, 2 mm broad and 1 mm thick; whitish, slightly ridged longitudinally; attachment scar sub-basal, immediately lateral to the tip of the base of the seed. Pappus about 10 mm long, deciduous, of numerous white setae, the longer setae shortly plumose.

Chromosome number. $2n = 26$ (Heiser and Whitaker 1948: as *C. picris*; Moore and Frankton 1954).

Native distribution. Mongolia, Western Turkestan, Iran, Turkish Armenia, Asia Minor.

Canadian distribution. This species is widespread in the Prairies: southwestern Manitoba, southern Saskatchewan, and Alberta. It is found also in south-central British Columbia, and in Ontario.

Russian knapweed is found in cultivated fields, pastures, and waste ground; it flowers from early July to September.

Russian knapweed is a serious weed — very persistent and difficult to eradicate. Propagation is by seed and also by the very deep rhizomes that are not reached by ordinary cultivation. Shoots from the underground stems produce extensive, dense clumps of plants.

Centaurea repens was introduced into North America with alfalfa seed from Russian Turkestan. This alfalfa seed was first imported into the United States in 1898 and was sown in Canada in 1900. Seed of Russian knapweed was first detected among the imported alfalfa seed in Canada in 1910 (Groh 1940). Until 1928 it was not known to be a pest in Canada but since then numerous infestations have been discovered and it has been classed as a noxious weed (Groh 1944).

DOUBTFULLY NATURALIZED SPECIES

Two ornamental species have been collected in the wild, as escapes from cultivation. They have been collected only once and it is not known whether they have persisted as naturalized members of our flora. The absence of later collections indicates that they did not become established and for this reason they have not been included in the key.

***C. macrocephala* Puschk.**

This species was collected near South Hull, Que., in 1948 (QFA).

The plant is perennial, about 9 dm high. The stems are simple or occasionally branched, bearing a single head of yellow flowers. The heads are about 4 cm high, involucre 2.5-3 cm high and as broad; all florets perfect and similar in size. The unarmed involucreal phyllaries are expanded into a chartaceous, palmately lacerate appendage, white or rusty in color. Basal cauline leaves are ovate-lanceolate, short petioled, irregularly serrate, lightly villous; upper leaves gradually diminishing in size, narrower than the basal leaves and slightly decurrent.

Centaurea macrocephala would come out at *C. jacea* in our key.

***C. moschata* L. sweet sultan**

A specimen was collected in "waste ground" at Coldstream, Vancouver Island, B.C., in 1936.

This species is an annual, about 6 dm high, with large heads of white, yellow, or purple flowers borne singly on long, naked peduncles. The flower heads are about 5 cm broad and 3 cm high; involucre about 1.5 cm high, phyllaries green, orbicular in shape, margin entire, thin. The leaves are variable in form, narrow and toothed or pinnatifid with dentate lobes.

In our key, *C. moschata* would come out with *C. repens*, from which it is readily distinguished by the above description.

HYBRIDS

Many putative natural interspecific *Centaurea* hybrids have been described from Europe. Some may be merely variant forms of species. Only one hybrid is known to occur in Canada: *C. × pratensis*. There seems to be reasonable morphological evidence that these plants are hybrids between *C. nigra* and *C. jacea*. In some European floras *C. pratensis* is not regarded as a hybrid but as a species related to *C. nigra* and *C. jacea*. Since *C. × pratensis* is of widespread occurrence in Canada, unlike the hybrids of the other genera herein, we have treated *C. × pratensis* in its natural position among related species.

CYTOLOGY

It will be noted that the chromosome numbers of the foregoing species reflect a variety of base numbers. Approximately 120 species of *Centaurea* — about 20% of the genus — have been cytologically examined. A wide range of chromosome numbers is found: $n = 8, 9, 10, 11, 12, 13, 15, 18, 20$. Of these, the numbers 9, 10, and 11 are the most frequent and almost all polyploid species are based on one of these numbers. We may speculate that the basic chromosome number of the ancient stock from which *Centaurea* s. lat. developed was 5, and that from this number, the numbers 4 and 6 were derived by the loss and addition of one chromosome. From the numbers 4, 5, and 6, the numbers 9 and 11 are derived by crossing. Doubling of primitive numbers has produced 8, 10, and 12. It is these derived numbers 8, 9, 10, 11, and 12 that are found as the haploid number in current species.

The number 13 seems to be most common in, if not wholly restricted to, several species that have by some botanists been referred to the segregate genera *Acroptilon*, *Leuzea*, and *Rhaponticum*. It may be that the number 13 arose from the crossing of the primitive basic number 5 and the derived polyploid number 8 and is thus a hybrid between “ancient” and more modern stock. These genera have thus arisen from crossing between two stocks at different levels of polyploidy — a process which differs from that postulated in the development of the species-groups which are generally accepted members of *Centaurea* s. str.

CNICUS Blessed thistle

Cnicus L., Sp. Pl. 826. 1753.

Tall, branched, annual herb. Leaves shallowly pinnatifid to subentire, upper leaves clasping the stem. Heads large, borne singly, surrounded by reduced leaves. Involucral phyllaries ovate to lanceolate, tipped by a spine that bears lateral spinules. Achenes with lateral attachment. Achenes bearing a ring of short, horny teeth and, within this crown, a pappus consisting of two circles of stout bristles.

Species now referred to the genus *Cirsium* were originally placed in *Cnicus*. The genus *Cnicus* now consists of a single species native to the Mediterranean region, extending to the Caucasus, Asia Minor, Armenia, Syria, Iran, Afghanistan, and perhaps Algeria.

Uses. Blessed thistle was long reputed to be a heal-all and was commonly grown in herb gardens. It was believed that this thistle was effective against the Plague and was able to ward off evil. Usually the leaves and flowering tops were dried and used as an infusion in water or wine. The infusion was taken as a general tonic, appetite stimulant, diaphoretic in fever cases, emetic, and blood purifier. Fresh leaves were eaten with bread as a general tonic (Grieve 1931).

Cnicus benedictus L., Sp. Pl. 826. 1753.

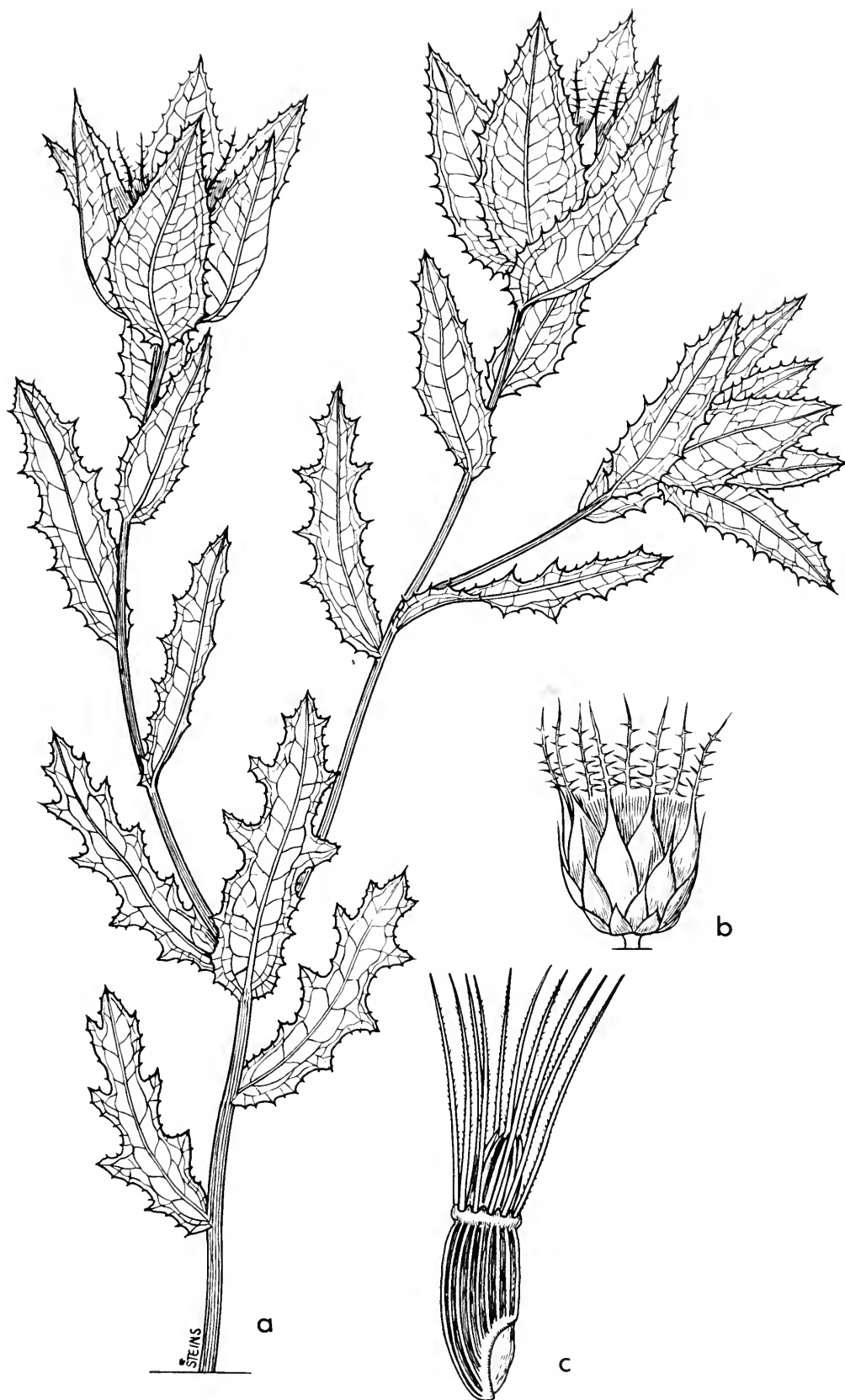
Centaurea benedicta L., Sp. Pl. 2nd ed., 1296. 1763.

Carbenia benedicta Benth. & Hook. f., Gen. pl. II, 482. 1873.

Carduus benedictus Hort.

Common names. Blessed thistle, holy thistle; chardon b nit

Annual herb, to 9 dm high, branched. Stems thick, often reddish, furrowed and pubescent. Leaves alternate, shallowly pinnatifid to subentire (small upper leaves), lanceolate to oblong in outline, lower leaves tapering to the base, base of upper leaves obtuse and sessile or clasping or sometimes fused with the stem; blades thin, veins prominent, glabrate on both surfaces with scattered short multicellular hairs, often dotted with a globular exudate, marginal spines short and fine. Heads 3-4 cm high, to 2 cm broad, single on the branches and surrounded by numerous, reduced, narrow leaves. Involucre 3-4 cm high, of 4 rows of phyllaries; the outer phyllaries short, ovate, about 4 mm broad, 8 mm long, and with slender 5-7 mm apical spine; the inner phyllaries progressively longer, ovate to lanceolate, with a terminal spine about 2 cm long, divergent, exceeding the involucre, the spine bearing a variable number of lateral spinules. Receptacle flat, bearing copious white chaff, 2 cm long. Flowers yellow. Corollas 19-22 mm long; tube 12-14 mm, lobes 1.5-3 mm. Anthers 4-5 mm long, filaments free. Pollen diam 17-20 μ m, walls smooth. Stigma 0.5 mm, clavate. Achenes 10-11 mm long, 2.5 mm wide,



Cnicus benedictus. **a**, habit, $\times 1\frac{1}{2}$; **b**, head, $\times \frac{2}{3}$, **c**, achene with pappus, $\times 3$.

slightly curved, attachment lateral, glossy brownish gray with about 20 deep, regular, longitudinal furrows. Achene crowned with a ring of 10 short horny teeth and, within this crown, the pappus consisting of a ring of 10 long (1 cm) and 10 short (3 mm) rigid bristles.

Chromosome number. $2n = 34$ (Vaarma 1947; Milovidov and Storchova 1958; Moore and Frankton 1962).

Canadian distribution. This species has been found as an escape only rarely in Canada. It has been reported for Nova Scotia, New Brunswick, and British Columbia, but only the report for New Brunswick has been confirmed.

The record from New Brunswick is based on a collection made at Bass River in August, 1864 and now preserved at Queen's University, Kingston, Ont. Macoun (1884, p. 272) reported *C. benedictus* from Nova Scotia but a search for the specimen on which this report is based was made by a colleague (B. Boivin) without success. It was reported from British Columbia (Campbell 1904) on the basis of a collection from adjacent Washington state. No specimen was found in the herbarium of McGill University where many of Campbell's collections are preserved.

REFERENCES

- Arano, H. 1957. The karyotype analysis and its karyotaxonomic considerations in some genera of subtribe Carduinae. *Jap. J. Genet.* 32:323-332.
- Arano, H. 1963. Biological studies in subfamily Carduoideae (Compositae) of Japan XII. Karyotype analysis in tribe Cynareae and genus *Arnica*. *Bot. Mag. (Tokyo)* 76:219-225.
- Arènes, J. 1949. Les races lusitaniennes de *Centaurea paniculata* L. *sensu latissimo*. *Agron. Lusit.* 11:3-26.
- Bobrov, E. G. 1962. *Echinops*. Flora U.S.S.R. XXVII, 1-53. Moscow & Leningrad.
- Boivin, B. 1966-67. Énumération des plantes du Canada. *Nat. Can.* 93:253-274; 371-437; 583-646; 989-1063; 94:131-157; 471-528; 625-655.
- Breitung, A. J. 1957. Annotated catalogue of the vascular flora of Saskatchewan. *Am. Midl. Nat.* 58:1-72.
- Briquet, J. 1902. Monographie des Centaurées des Alpes maritimes. Georg & Co., Bale et Genève. 193 p.
- Campbell, R. 1904. Some conspicuous British Columbia summer plants. *Can. Rec. Sci.* 9:176-189.
- Carter, W. R., and Newcombe, C. F. 1921. A preliminary catalogue of the flora of Vancouver and Queen Charlotte Islands. *Prov. Mus. Nat. Hist. B.C. Victoria*.
- Charadze, A. L. 1963. *Cirsium*. Flora U.S.S.R. XXVIII, 51-215. Moscow & Leningrad.
- Chiappini, M. 1954. Recherche sullo aviluppo embriologico di alcune specie del genere *Centaurea* L. (Asteraceae). *Nuovo G. Bot. Ital.* 61:274-289.
- Covas, G., and Schnack, B. 1947. Estudios cariologicos an Antofitas II. *Rev. Argent. Agron.* 14:224-231.
- Cronquist, A. 1955. Vascular plants of the Pacific Northwest. Part 5. Univ. Washington, Seattle.
- Czapik, R. 1958. Karyotypical studies in species of *Cirsium* Mill. em. Scop. occurring in Poland. *Acta Soc. Bot. Pol.* 27:483-489.
- Dodge, C. K. 1914. The flowering plants, ferns and fern allies growing without cultivation in Lambton County, Ontario. *Mich. Acad. Sci. 16th Rep.* pp. 136-200.
- Dore, W. G. 1961. A centennial floristic census of Prescott, Ontario. *Trans. R. Can. Inst.* 33:49-115.
- Eames, E. H. 1909. Notes upon the flora of Newfoundland. *Rhodora* 11:87-99.
- Eastham, J. W. 1947. Supplement to 'Flora of British Columbia.' B.C. Prov. Mus., Special Publ. No. 1.
- Ehrenberg, L. 1945. Kromosomtalen hos nagra karlväxter. *Bot. Not.* 1945:430-437.
- Fernald, M. L. 1933. Recent discoveries in the Newfoundland flora. *Rhodora* 35:364-386.
- Fernald, M. L. 1950. *Gray's Manual of Botany*. 8th ed. American Book Co.
- Frankton, C., and Moore, R. J. 1961. Cytotaxonomy, phylogeny and Canadian distribution of *Cirsium undulatum* and *Cirsium flodmanii*. *Can. J. Bot.* 39:21-33.

- Frankton, C., and Moore, R. J. 1963. Cytotaxonomic notes on some *Cirsium* species of the western United States. *Can. J. Bot.* 41:1553-1567.
- Fraser, W. F., and Russell, R. C. 1944. A revised annotated list of the plants of Saskatchewan. Univ. Saskatchewan, Saskatoon. 64 pp.
- Fröst, S. 1948. B and ring chromosomes in *Centaurea scabiosa*. *Hereditas* 34:255-256.
- Gadella, T. W. J., and Kliphuis, K. 1963. Chromosome numbers of flowering plants in the Netherlands. *Acta Bot. Neerl.* 12:195-230.
- Gadella, T. W. J., and Kliphuis, E. 1966. Chromosome numbers of flowering plants in the Netherlands: II. *K. Nederl. Akad. Wet. Ser. C.* 69:541-556.
- Gardou, C. 1962. Nouvelles observations sur les types diploides de *Centaurea jacea* L. ssp. *angustifolia* Greml. *Rev. Cytol. & Biol. Veg.* 25:367-373.
- Gardou, C. 1969. Caryosystematique des Centaurées de la section *Acrocentron* Cass. (in Hoffman, 1897). *Bull. Soc. Bot. France* 116:29-38.
- Gleason, R. A., and Cronquist, C. 1963. Manual of vascular plants of Northeastern United States and adjacent Canada. Van Nostrand, Princeton, N.J.
- Gorecka, A. 1956. Cytological studies in three species of *Carduus* L. *Acta Soc. Bot. Pol.* 25:719-731.
- Grieve, M. 1931. A modern herbal. Vol. II. Jonathan Cape Ltd., London.
- Groh, H. 1940. Turkestan alfalfa as a medium of weed introduction. *Sci. Agr.* 21:35-43.
- Groh, H. 1944. Canadian weed survey. Second Annual Report 1943. Can. Dep. Agric. Mimeo. 74 pp.
- Guinochet, M. 1956a. Sur une forme diploide remarquable de *Centaurea jacea* L. *C. R. Acad. Paris* 243:1783-1785.
- Guinochet, M. 1956b. Sur l'existence d'une forme systematique chez *Centaurea paniculata* L. *C. R. Acad. Paris* 243:2130-2132.
- Guinochet, M. 1957a. Quelques remarques sur les relations cytogénétiques entre les *Centaurea montana* L. et *Triumfetti* All. *C. R. Acad. Paris* 244:1950-1952.
- Guinochet, M. 1957b. Contribution a l'étude caryologique du genre *Centaurea* L. sens. lat. *Bull. Soc. Hist. Nat. Afr. Nord* 48:282-300.
- Guinochet, M., and Foissac, J. 1962. Sur les caryotypes de quelques espèces du genre *Centaurea* L. et leur signification taxonomique. *Rev. Cytol. & Biol. Veg.* 25:373-378.
- Guire, K. E., and Voss, E. G. 1963. Distribution of distinctive shoreline plants in the Great Lakes region. *Mich. Bot.* 2:99-114.
- Hansen, A. A. 1918. Canada thistle and methods of eradication. U.S. Dep. Agric. Farmer's Bull. 1002.
- Hayek, A. 1931. Prodrum florae peninsulae Balcanicae. *Repert. Spec. Nov. Reg. Veg. Beih.* Vol. 30(2). Berlin-Dahlem.
- Hegi, G. 1929. Illustrierte Flora von Mittel-Europa. Vol. 6(2). Munich.
- Heiser, C. B., and Whitaker, T. W. 1948. Chromosome numbers, polyploidy and growth habit in California weeds. *Am. J. Bot.* 35:179-186.
- Holt, G. W. 1902. Is *Cirsium palustre* a native of New Hampshire? *Rhodora* 4:217.

- Howell, J. T. 1959. Distributional data on weedy thistles in western North America. *Leaflet. West. Bot.* 9:17-29.
- Hultén, K. 1950. *Flora of Alaska and Yukon*. Vol. 10. Lund.
- Johnson, A. W., and Packer, J. C. 1968. Chromosome numbers in the flora of Ogotruk Creek, N.W. Alaska. *Bot. Not.* 121:403-456.
- Johnson, M. F., and Iltis, H. H. 1962. Preliminary reports of the flora of Wisconsin. No. 48. *Compositae* 1 — Composite Family 1. *Trans. Wisc. Acad. Sci., Arts & Lett.* 52:255-342.
- Josselyn, J. 1672. *New England rarities discovered in birds, beasts, fishes, serpents and plants of that country*. London (Fascimile edition, W. Junk, Berlin. 1926).
- Kalm, P. 1966. *Peter Kalm's travels in North America*. (English Version of 1770, revised by A. B. Benson. 2 vol.) Dover Publ., New York.
- Kazmi, S. M. A. 1963-4. Revision der Gattung *Carduus* (Compositae) I, II. *Mitt. Bot. Munchen* 5:139-198, 279-550.
- Klokov, M. B., Sosnovskii, D. I., Tsvelev, N. N., and Cherepanov, C. K. 1963. *Centaurea*. *Flora U.S.S.R.* XXVIII, 370-579. Moscow & Leningrad.
- Larsen, K. 1956. Chromosome studies in some Mediterranean and south European flowering plants. *Bot. Not.* 109:293-307.
- Lipschitz, S. U. 1962. *Saussurea*. *Flora U.S.S.R.* XXVII, 361-535. Moscow & Leningrad.
- Löve, A., and Löve, D. 1944. Cytotaxonomical studies in boreal plants III. *Ark. Bot.* 31 A (12):1-22.
- Macoun, J. 1884. *Catalogue of Canadian plants*. Part II. Montreal.
- Marsden-Jones, E., and Turrill, W. B. 1954. *British knapweeds*. Ray Society, London.
- Millivodov, P., and Storchova, J. 1958. Ueber die Chromosomenzahlen Heilpflanzen. *Oesterr. Bot. Z.* 105:293-300.
- Montgomery, F. H. 1956. *Common weeds of Ontario*. Ont. Dep. Agric. Bull. 505.
- Moore, R. J. 1968. In IOPB chromosome number reports XVIII. *Taxon* 17:419-422.
- Moore, R. J., and Frankton, C. 1954. Cytotaxonomy of three species of *Centaurea* adventive in Canada. *Can. J. Bot.* 32:182-186.
- Moore, R. J., and Frankton, C. 1962a. Cytotaxonomic studies in the tribe Cynareae (Compositae). *Can. J. Bot.* 40:281-293.
- Moore, R. J., and Frankton, C. 1962b. Cytotaxonomy and Canadian distribution of *Cirsium edule* and *Cirsium brevistylum*. *Can. J. Bot.* 40:1187-1196.
- Moore, R. J., and Frankton, C. 1963. Cytotaxonomic notes on some *Cirsium* species of the western United States. *Can. J. Bot.* 41:1553-1567.
- Moore, R. J., and Frankton, C. 1964. A clarification of *Cirsium foliosum* and *Cirsium drummondii*. *Can. J. Bot.* 42:451-561.
- Moore, R. J., and Frankton, C. 1965. Cytotaxonomy of *Cirsium hookerianum* and related species. *Can. J. Bot.* 43:597-613.
- Moore, R. J., and Frankton, C. 1966. An evaluation of the status of *Cirsium pumilum* and *Cirsium hillii*. *Can. J. Bot.* 44:581-595.
- Moore, R. J., and Frankton, C. 1967. Cytotaxonomy of foliose thistles

- (*Cirsium* spp. aff. *C. foliosum*) of western North America. Can. J. Bot. 45:1733-1749.
- Moore, R. J., and Frankton, C. 1969. Cytotaxonomy of some *Cirsium* species of the eastern United States, with a key to eastern species. Can. J. Bot. 47:1257-1275.
- Moore, R. J., and Mulligan, G. A. 1956. Natural hybridization between *Carduus acanthoides* and *Carduus nutans* in Ontario. Can. J. Bot. 39:21-33.
- Moore, R. J., and Mulligan, G. A. 1964. Further studies on natural selection among hybrids of *Carduus acanthoides* and *Carduus nutans*. Can. J. Bot. 42:1605-1613.
- Morinaga, T., Fukushima, E., Maruyama, Y., and Yamasaki, Y. 1929. Chromosome numbers of cultivated plants: II. Bot. Mag. Tokyo 43:589-594.
- Morisett, P. 1971. Endemism in the vascular plants of the Gulf of St. Lawrence region. Nat. Can. 98:167-177.
- Mulligan, G. A. 1961. Chromosome numbers of Canadian weeds: III. Can. J. Bot. 39:1057-1066.
- Mulligan, G. A., and Frankton, C. 1954. The plumeless thistles (*Carduus* spp.) in Canada. Can. Field Nat. 68:31-36.
- Mulligan, G. A., and Moore, R. J. 1961. Natural selection between *Carduus acanthoides* and *C. nutans* in Ontario. Can. J. Bot. 39:269-279.
- Mulligan, G. A., and Porsild, A. E. 1969. Chromosome numbers of some plants from the unglaciated central Yukon Plateau, Canada. Can. J. Bot. 47:655-662.
- Nakajima, G. 1936. Chromosome numbers in some crops and wild angiosperms. Jap. J. Genet. 12:211-218.
- Ownbey, G. B. 1951. Natural hybridization in the genus *Cirsium*: I. *C. discolor* (Muhl. ex Willd.) Spreng. \times *C. muticum* Michx. Bull. Torrey Bot. Club 78:233-253.
- Ownbey, G. B., and Hsi, Y-T. 1963. Chromosome numbers in some North American species of the genus *Cirsium*. Rhodora 65:339-354.
- Packer, J. G. 1964. Chromosome numbers and taxonomic notes on western Canadian and Arctic plants. Can. J. Bot. 42:473-494.
- Poddubnaja, W. 1927. Spermatogenesis bei einigen Compositen. Planta 4:284-298.
- Poddubnaja-Arnoldi, V. 1931. Ein Versuch der Anwendung der embryologischen Methode bei der Lösung einiger systematischer Fragen. I. Vergleichende Embryologisch-zytologische Untersuchungen über die Gruppe Cynareae, Fam. Compositae. Beih. Bot. Centralbl. 48:141-237.
- Podlech, D. 1964. In Documented chromosome numbers of plants. Madrono 17:266-268.
- Porsild, A. E. 1966. Contributions to the flora of southeastern Yukon Territory. Contr. to Botany IV. Nat. Mus. Can. Bull. 216. pp. 1-86.
- Roland, A. E. 1945. The flora of Nova Scotia. Truro, N.S.
- Rousseau, C. 1968. Histoire, habitat et distribution de 250 plantes introduites au Québec. Nat. Can. 95:49-169.
- Rousseau, J., and Raymond, M. 1945. Études ethnobotaniques Québécoises. Contr. Inst. Bot. Univ. Montréal No. 55.

- Rouy, G., and Camus, E. G. 1901. Flore de France. Paris.
- Roy, B. 1937. Chromosome numbers in some species and hybrids of *Centaurea*. J. Genet. 35:89-93.
- Runemark, H. 1967. Studies in the Aegean Flora: XII. Cytologic and morphologic investigations in *Centaurea*. Bot. Not. 120:161-176.
- Salisbury, E. 1961. Weeds and aliens. Collins, London.
- Skalinska, M., Czapik, R., Piotrowicz, M., et al. 1959. Further studies in chromosome numbers of Polish Angiosperms (Dicotyledons). Acta Soc. Bot. Pol. 28:487-529.
- Skalinska, M., Piotrowicz, M., Sokolowaka-Kulczycka, A., et al. 1961. Further additions to chromosome numbers of Polish Angiosperms. Acta Soc. Bot. Pol. 30:463-489.
- Sokolovskaya, A. P. 1966. Geograficheskoe rasprostranenie polyploidnykh vidov rasteny. Vestnik Leningrad Univ., Ser. Biol. 3:92-106.
- Sorsa, V. 1962. Chromosomenzahlen Finnischer Kormophyten I. Ann. Acad. Sci. Fenn., Ser. A. IV Biol. 58:1-14.
- Sturtevant, E. L. 1919. Sturtevant's notes on edible plants. Edited by U. P. Hedrick. N. Y. State Dep. Agric. Ann. Rep. 1918-19. 27th Annu. Rep. Vol. 2 Part 2. 686 pp.
- Sugiura, T. 1931. A list of chromosome numbers in angiospermous plants. Bot. Mag. (Tokyo) 45:353-355.
- Sugiura, T. 1936. Studies on the chromosome numbers in higher plants with special reference to cytokinesis. I. Cytologia 7:544-595.
- Tischler, G. 1950. Die Chromosomenzahlen der Gefässpflanzen Mitteleuropas. W. Junk, The Hague.
- Vaarma, A. 1947. Some chromosome numbers in the genera *Angelica*, *Ocimum*, *Satureja*, *Thymus* and *Cnicus*, Arch. Soc. Zool. Bot. Fenn. 'Vanamo'. 2:55-59.
- Vignoli, L. 1945. I cromosomi di *Centaurea calcitrapa* L. e *Centaurea macroantha* Guss. Nuovo G. Bot. Ital. 52:11-13.
- Weatherby, C. A., and Adams, J. 1945. A list of the vascular plants of Grand Manan, Charlotte County, New Brunswick. Contr. Gray Herb. Harvard. No. 158.
- Wulf, H. D. 1937. Chromosomenstudien an der Schleswig-holsteinischen Angiospermenflora. I. Ber. Dtsch. Bot. Ges. 55:262-269.
- Yanovsky, E. 1936. Food plants of the North American Indians. U.S. Dep. Agric. Misc. Publ. 237. 84 p.
- Young, S., Brown, W. W., and Klinger, B. 1970. Nigropallidal Encephalomalacia in horses caused by the ingestion of weeds of the genus *Centaurea*. J. Am. Vet. Med. Assoc. 157:1602-1605.
- Youngken, H. W. 1948. A textbook of pharmacognosy. 4th ed. Blakiston, Philadelphia.
- Zhukova, P. G. 1964. The caryology of some species of Compositae growing in the Arctic-alpine Botanic Garden (Kola Peninsula). (in Russian) Bot. Zh. (Moscow & Leningrad) 49:1656-1659.
- Zhukova, P. G. 1969. Chromosome numbers in certain plant species indigenous to the north-east of the U.S.S.R. (in Russian) Bot. Zh. (Moscow & Leningrad) 54:1985-1990.

SELECTED GLOSSARY

- achene* — a dry, indehiscent 1-seeded fruit
acuminate — tapering to a gradual point
annual — lasting 1 year
anther — pollen-bearing sac of a stamen
apiculate — ending in an abrupt, short point
appendage — an extension of an organ, especially when dissimilar in appearance
appressed — lying close to or flat against; phyllary tips lying against the involucre, not spreading (compare “spreading”)
arachnoid — cobwebby, with loose, long, entangled hairs
ascending — rising or curving upward (leaves, branches)
asperous — rough or harsh
attenuate — tapering gradually; becoming long and narrow
biennial — lasting 2 years
bract — a small modified leaf
canescent — bearing gray pubescence
capitulum — head; dense cluster
cauline — on the stem
chartaceous — paper-like in texture or appearance
cilia — marginal hairs or fine hair-like, flexible processes
clasping (leaf base) — partially encircling the stem
clavate — club-shaped; gradually thickened upward
coriaceous — leathery in texture
corolla — inner perianth of a flower, consisting of separate or fused petals
corymb — a flat-topped flower cluster; flowers, or flower heads, on stalks of various lengths from the stem, so that the flowers are at approximately the same level
corymbose — arranged in a corymb
deciduous — falling off, not persisting
decurrent — extending downward from the point of insertion; leaf tissue extending as wings down the stem from the point of leaf attachment
deltoid — triangular
dioecious — unisexual: male and female flowers on separate plants
eglandular — lacking glands
entire (leaf) — not divided
eradiate (head) — all florets of the head similar in size, without larger, ray-like peripheral florets
erose — irregularly cut, as if gnawed
filament — the thread-like stalk that supports anthers; any thread-like structure
floccose — bearing tufts of soft hairs
floret — single flower of a head
gamopetalous — having the petals (at least the basal portions) united laterally
glabrous — smooth, without hairs
gland — a globular-tipped hair (on leaves, stems, flowers); a sticky secreting area, usually a narrow dark zone (on surface of phyllaries)
glandular — bearing glands

glutinous — bearing a sticky exudate
habit — general appearance of a plant
habitat — type of locality in which a plant grows
inflorescence — the flowering portion of a plant, an assemblage of flowers, referring especially to the arrangement of the flowers, or flower heads, relative to the main stem
invagination — inward curving (as of a margin) resulting in a localized narrowing of the organ
involucre — the circle of bracts (phyllaries) surrounding the flower head
lacerate — irregularly cleft, as if torn
lacinate — cut into narrow pointed segments; slashed
lanceolate — several times longer than broad and broadest at the base
linear — long and narrow, with parallel margins
limb — the broader upper portion of a gamopetalous corolla, consisting of the throat and lobes
lobe — the separate segments of the upper portion of a gamopetalous corolla
membranous — thin and flexible
monoecious — stamens and pistils in separate flowers on the same plant
ob (prefix) — inverted; as a shape, reversed regarding the position of the greater dimension
oblanceolate — inverted lanceolate: broader toward the apex
obovate — inverted ovate: the apical portion broader than the base
obtuse — rounded at the end, blunt
ovary — the dilated basal portion of a pistil, bearing the ovules
ovate — egg-shaped, broader at the base
paleaceous — chaff-like
panicle — a loose, irregularly compound inflorescence, as a branched corymb or raceme
pappus — a crown of filaments, scales, bristles, chaff, etc. on the summit of the achene
pectinate — comb-like: with fine, stiff processes
pedicel — stalk of a single flower
peduncle — a primary flower stalk, bearing either a single flower or a cluster
petiole — stalk of a leaf
perennial — lasting year after year
perfect (flower) — with both pistil and stamens in one flower
perianth — floral envelope, calyx and corolla (if present)
phyllary — a bract of the involucre
pilose — bearing long, soft, straight hairs, rather shaggy
pinnate — compound (leaf); with the leaflets arranged on each side of a common axis
pinnatifid — divided in a pinnate manner; a leaf divided into pinnately arranged segments
pistil — the female, seed-bearing organ of a flower, consisting of ovary, style, and stigma
plumose — feathery; hairs or filaments with lateral branches
pubescent — covered with hairs

raceme — an inflorescence consisting of flowers, or heads, along an elongate axis, the flower stalks similar in length so that the flowers are not located at the same level
racemose — arranged in a raceme
radiate (head) — having the peripheral florets of the head larger than the central florets
rameal — on branches
receptacle — the expanded terminal portion of the flower stem, to which the floral organs are attached; in Compositae, the fleshy portion of the head to which the florets and involucre bracts are attached
reflexed — bent abruptly backward
remote (leaf segments) — not close together
repand — somewhat uneven or wavy
rugulose — minutely wrinkled
scabrid — rough to the touch
sericeous — silky
setae — bristles, stiff hairs, fibers; silk plumose fibers in *Cirsium*
sessile — attached directly, without a stalk
simple — undivided or unbranched
sinus (leaf) — cleft between lobes
spatulate — oblong, the basal portion narrow
spreading (phyllaries) — the phyllary tips standing out from the involucre (compare “appressed”)
stamen — the male, pollen-bearing organ of a flower, consisting of anther and filament
stigma — the terminal portion of a pistil, which receives the pollen
style — the attenuated portion of the pistil, between stigma and ovary
sub (prefix) — below; almost; to a lesser degree
subulate — bearing an abrupt sharp point
throat — the undivided, broad, median portion of a gamopetalous corolla
tomentose — densely hairy, matted wool
tube — the basal portion of a corolla, in our plants the tube is distinctly narrower than the remainder of the corolla
unarmed — lacking spines
undulating — having a wavy surface or margin
villous — bearing long, soft, often curly hairs, not interwoven

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CONVERSION FACTORS FOR METRIC SYSTEM

Imperial units	Approximate conversion factor	Results in:
LINEAR		
inch	x 25	millimetre (mm)
foot	x 30	centimetre (cm)
yard	x 0.9	metre (m)
mile	x 1.6	kilometre (km)
AREA		
square inch	x 6.5	square centimetre (cm ²)
square foot	x 0.09	square metre (m ²)
acre	x 0.40	hectare (ha)
VOLUME		
cubic inch	x 16	cubic centimetre (cm ³)
cubic foot	x 28	cubic decimetre (dm ³)
cubic yard	x 0.8	cubic metre (m ³)
fluid ounce	x 28	millilitre (mℓ)
pint	x 0.57	litre (ℓ)
quart	x 1.1	litre (ℓ)
gallon	x 4.5	litre (ℓ)
bushel	x 0.36	hectolitre (hℓ)
WEIGHT		
ounce	x 28	gram (g)
pound	x 0.45	kilogram (kg)
short ton (2000 lb)	x 0.9	tonne (t)
TEMPERATURE		
degree fahrenheit	°F-32 x 0.56 (or °F-32 x 5/9)	degree Celsius (°C)
PRESSURE		
pounds per square inch	x 6.9	kilopascal (kPa)
POWER		
horsepower	x 746 x 0.75	watt (W) kilowatt (kW)
SPEED		
feet per second	x 0.30	metres per second (m/s)
miles per hour	x 1.6	kilometres per hour (km/h)
AGRICULTURE		
bushels per acre	x 0.90	hectolitres per hectare (hℓ/ha)
gallons per acre	x 11.23	litres per hectare (ℓ/ha)
quarts per acre	x 2.8	litres per hectare (ℓ/ha)
pints per acre	x 1.4	litres per hectare (ℓ/ha)
fluid ounces per acre	x 70	millilitres per hectare (mℓ/ha)
tons per acre	x 2.24	tonnes per hectare (t/ha)
pounds per acre	x 1.12	kilograms per hectare (kg/ha)
ounces per acre	x 70	grams per hectare (g/ha)
plants per acre	x 2.47	plants per hectare (plants/ha)

Examples: 2 miles x 1.6 = 3.2 km; 15 bu/ac x 0.90 = 13.5 hℓ/ha



INFORMATION
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Ottawa

IF UNDELIVERED, RETURN TO SENDER EN CAS DE NON-LIVRAISON, RETOURNER À L'EXPÉDITEUR